

# THE MODEL ENGINEER



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# The MODEL ENGINEER

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VOL. 100 NO. 2486

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## SMOKE RINGS

### It is the Urge that Does It

WITH CHRISTMAS over, most model engineers begin to prepare for the New Year and, we hope, make the usual good resolutions. Probably the first resolution which occurs to the mind of the average home-craftsman is to concentrate on completing that new model, so that when the longer days come round once more, it can be tried out on the track, on the water, or in the air, as the case may be.

Others—and we hope they are many—will surely be thinking of getting on with that new model, so that it will be ready in time for the next MODEL ENGINEER Exhibition. Our Mr. E. D. Stogden has been working for some time upon ideas for the next "M.E." show; but it is too soon yet for us to tell you anything about his plans.

Winter or Summer, however, there is always something for the model engineer to be doing; the rapidity of his progress depends upon several things, singly or collectively, such as the time he is able to give to the hobby, his skill in the use of his workshop equipment, the degree of his enthusiasm, the amount of detail he intends to include in what he is making, or his financial

resources. Each has some effect; but the urge to get on is always there, for nothing would ever be done if it were not.

### To Club Secretaries

NOW THAT so many new clubs have come, and are coming, into existence, we feel that we should remind secretaries that all announcements sent to us for publication must reach this office at least fourteen days ahead of the publication date. We would add that, so long as the shortage of paper remains acute, we must request that announcements and reports shall be brief and to the point. We cannot guarantee that we shall publish all the announcements we receive; we try, as far as possible, to deal with them in rotation, though the dates mentioned in the reports must, of course, be taken into consideration, and the amount of space available is also a governing factor.

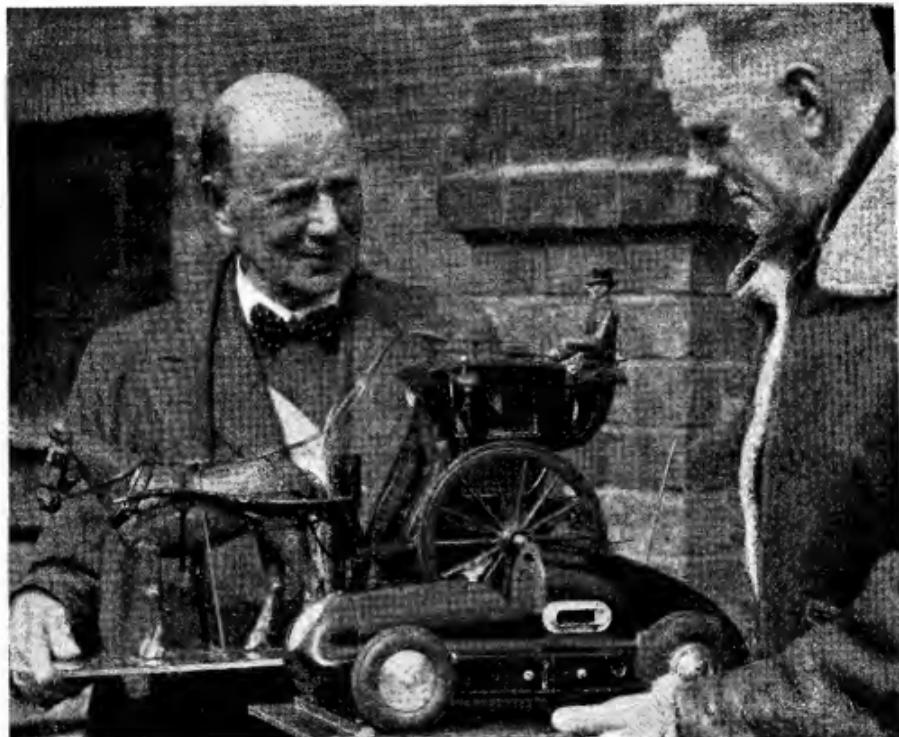
Would all Public Relations Officers please note that much of our editorial time would be saved, and mistakes avoided, if every club notice sent to us bears the name and full address of the acting secretary of the club instead of that of the P.R.O.

**Extremes Meet**

● THE PHOTOGRAPH reproduced on this page is of interest in that it represents, in a way, two violently contrasting forms of transport by land : a hansom cab and a racing car. Mr. Peter Winton, with the cab, and Mr. H. H. Crooks, with the car, are both members of the Handley

share of taxation based on logical definitions.

Recently, however, modifications have been made to the regulations and have brought about some anomalies which have aroused considerable criticism. Previously, purchase tax had applied only to completed models, but now some of the components are subject to 33 1/3 per cent. tax ;



Page Model Engineering Society. Each of the models is an excellent example of its kind ; the cab, which is also seen in our cover picture, was exhibited at last year's "M.E." Exhibition, where it attracted a lot of attention. The car is capable of reaching a speed of 90 m.p.h.

**The Purchase Tax**

● WE FREQUENTLY receive complaints about the prevailing high prices of even very small components which model engineers have to purchase. Some readers seem to think that manufacturers and retailers are entirely to blame ; but we know that this idea is far from correct, because everybody in the trade has to comply with the regulations governing purchase tax. The model engineering trade, realising the urgent needs of the national exchequer, is willing to play its part by cheerfully accepting a reasonable

and, as most of these when *not* sold as "an accessory or part of a toy" are *not* subject to tax, the absurdity of the situation is apparent to all except the Customs and Excise authorities ! The question arises as to who decides when "an accessory or part of a toy" is no such thing.

The Model Engineering Trade Association is attacking the problem with vigour, even to the length of sending a deputation to the Chancellor of the Exchequer to discuss the matter with him, and we hope that it may lead to the removal of the anomalies if not the entire tax. Customers as well as traders must be protected from all forms of unfairness.

**The Latest Spoonerism**

● WE COULD not restrain a smile for the gentleman who told us that he had cut a recess in a slab of metal by means of chilling and dripping !

# A Tudor Gem



A 1/72-scale model of Anne of Cleves' House at Ditchling, Sussex

MODELMAKERS live in a Lilliputian world. I often wish I could reduce myself to a being an inch high and take a stroll around my model.

The construction of this little house was begun in September, 1945, and finished in August, 1946, some 400 hours being spent on the work.

After obtaining permission from the owners, I took accurate measurements of the ground plan, windows, doors and drop-lights, after which I made up a base out of plywood, 1 in. thick, with a cut-out for the lighting unit.

The beams are made of oak, cut to  $\frac{1}{8}$ -in. and  $\frac{1}{4}$ -in. square sections, and built up as in the original, pinned and glued together.

Here I may mention that photography helped me a lot in duplicating the distorted, aged timbers. The model now looked like a bird-cage of wood. The intended procedure was to reproduce the brick-and-plaster filling between the beams, and for this I found plaster-of-paris too brittle; wood stopping, with pear-drop smell, too quick-drying, and various oil pastes too messy! Finally, I decided on "Alabastine" for white plaster and "Hold Firm" for the brickwork.

A word about these: "Alabastine" swells slightly and does not crack, and it gives an excellent base for oil tints. "Hold Firm" shrinks and cracks, giving a natural, aged appearance to brickwork, while, being oil-bound, it gives one time to mould or score it.

Next came the window-frames, which were

made from pine and spruce cut with a razor-blade. Lead lights were fashioned out of wire mesh coated with gelatine; and here I took care to make diamond and square frames distinguishable, according to the photographs.

By now, we had reached the eaves. Roof-tiles were roughly to scale, and, even then, there were about ten thousand of them to stick on; but the result well repaid the time and patience involved. The gutters were made from umbrella-ribs, and the drain-pipes from soft iron wire.

Now for the colouring. To me, nothing but artists' oil-colours is better suited to this job. The roof was a joy to do, with its rich siennas and lichens. Brickwork was reproduced by only a suggestion of lines on a base colour. Creepers were worked up in solid oil-colour stippled with a pen-knife, and sanded walls were oil-colour mixed with sifted sand. All upper surfaces were thinly copal-varnished.

The wrought-iron gate is worth special mention; I made it from bronze wire, bent to shape and soldered, a job that required a lot of patience.

Last, the lighting unit, which consists of two 3-volt lamps and appropriate battery, each lamp being surrounded by four tinted glasses to mask the appearance of the lamps. The whole assembly is inserted in the base, and when the light is switched on the appearance behind the gelatine windows is most gratifying. The award of a Bronze Medal at THE MODEL ENGINEER Exhibition has spurred me on to even better efforts next time.—GEO. CLASBY.

# \*CONCERNING MODELS

Describing half a century of model making and the building of "Amalgamation"—1946 "M.E." Championship Cup winner

by S. T. Harris

NEXT came a traction engine (showman's N type) for my son as a Christmas present. I fitted a Stuart dynamo and canopy with three two-volt electric lamps. It is  $\frac{3}{4}$ -in. bore  $\times$   $1\frac{1}{2}$ -in. stroke and has steam-jacketed cylinder, balanced crank-shaft, link reversing-gear, eccentric and hand pump with by-pass and governor. I made a gas burner to fire it so that my son could run it

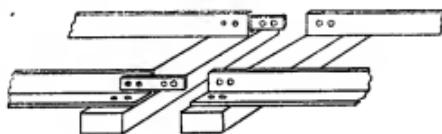


Fig. 1

and drive the dynamo indoors; and he did run it, believe me! It was made of odds and ends, except for the boiler which was a proper fire-tube one with water space around firebox, and brazed throughout and tested to 200 lb. hydraulic. It took me secretly 12 months to complete, but was worth it. Of course, I did not put much finish into it.

I then thought about running the locomotive, as my son wanted to see it run under steam; so I laid down a temporary track made with 1 in.  $\times$  1 in.  $\times$   $\frac{1}{2}$  in. angle-steel, as sketch Fig. 1,

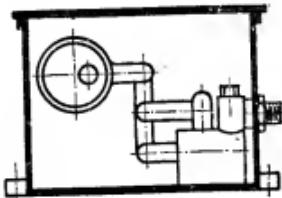


Fig. 2

with battens at 6 in. intervals, and this was simply laid on the garden path, about 50 ft. in all. It was in 6 ft. lengths, and the joints had a plate permanently fixed on one end of the angle and extended over the angle about 2 in. This lapped the end of the next angle at each joint and was fixed with screws, as sketch. It answered very well, and it was taken up after the run and stored away until the next time.

My son was then about ten years old, and he

became quite an expert driver. For a trolley I used the old bogie wheels and the tender chassis, fitting ball-bearings and hand-brake. This ran very well, after I had got the blast-pipe adjusted correctly, from about 1927 to 1935, and gave endless pleasure to both my son and myself, also to the many school friends of my son.

During the years I was without a workshop,

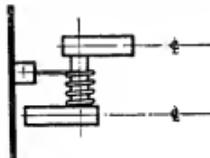


Fig. 3

I had sold my lathe and chucks, but kept all my other tools, as I had nowhere convenient to keep the lathe except in a cupboard which was damp. My son was now about eleven years old, and wanted to try his hand at a bit of model making, so I decided to build myself a workshop outside. The largest I could get was 7 ft. 6 in. long by 5 ft. wide, using the wall of the house for the back. I fitted a hinged skylight in the roof and two windows to open at the sides, matchboarded the inside and tongued-and-grooved flooring, covered with lino which had been discarded from the house, and air-bricks under floor.

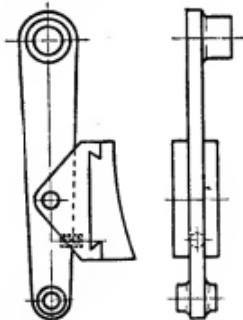


Fig. 4

I wired it for light and two power points, one for the motor, and one for a radiator to keep me warm and also to keep the workshop dry. I then purchased a Pool 4-in. lathe, necessary

\*Continued from page 6, "M.E.", January 6, 1949.

material for countershaft and  $\frac{1}{2}$ -h.p. motor. This I rigged up, fitted a bench (I had kept my tools, but had chucks to buy and fit) and we were ready once again.

It was February, 1935, and the locomotive wanted one or two jobs doing to it; so we now got this out and set about it. But my son said

"What about making another one instead?" I said we would, and it was decided to make a freelance model 5-in. gauge. A line drawing of a 4-6-0 was made by my son, and this was the only drawing used for the chassis. The boiler was drawn out half-size at a later date, and "L.B.S.C." was consulted. It was never intended to make this engine an "exhibition" model; but somehow or other, as it grew I became more fussy about it.

In the first place, it was going to be outside cylinders only, so we visited Kennion's and bought the cylinders, the 6-in. driving wheels and the bogie wheels, and horn castings. I had already bought the frame steel, bronze, etc. for horn blocks, and sundry bits and pieces. The chassis was partly finished when my son suggested that I made it into a four-cylinder engine; so we purchased the inside block, machined and fitted it. My son had turned all the axles and roughed-out the bogie wheels, but the drivers I turned on a 6½-in. toolroom lathe. I had to press off the middle pair of drivers, make a crankshaft for the inside cylinders and refit; all this meant extra work, of course, as there was the inside motion.

The valve-gear is operated by rockers from the outside gear and the only castings used for the engine were for the wheels, cylinders and horn cheeks; all the rest was fabricated, or cut from the solid. The fluting of all rods was managed on the Pool lathe with the aid of a vertical slide. The two mechanical lubricators each have two horizontal pumps,  $\frac{1}{16}$  in. in each

case (Fig. 2), worked through rocker-shafts from eccentrics; but instead of a second pawl to hold it from turning back, I fitted a phosphor-bronze spring wound tightly round the driving spindle as in some gramophone winding-gears, and in telephones. (Sketch Fig. 3.) The delivery valves for these lubricators, and the check-valves on the cylinders are spring-loaded. The ratchet-wheels for driving them were cut with a flycutter held in the chuck and a rig-up for dividing fixed on vertical slide. A drawing of one of these lubricators is reproduced herewith.

The brakes are compensated, and the blocks are of rosewood held in by dovetailing; a small spring underneath holds these up so that they do not rub on the wheels when in the off position. (Sketch Fig. 4.) All the brakes, including those on the tender, are steam-operated.

The drain-valves are operated by one lever in the cab. There are three dampers operated by separate levers. Reverse is by a two-start thread. Regulator is of Willoughby's design as described in *THE MODEL ENGINEER* for May 26th, 1927; but it has two reaching up into a dome which is covered by a cab roof and cannot be seen.

Two coiled springs are fitted under each driving axlebox, and leaf-springs over each bogie wheel. Driving axles are lubricated from lubricators fitted behind the nameplates and feeding down to boxes by  $\frac{1}{8}$ -in. piping.

After I had quite a bit of this work done, I met an old acquaintance who was a driver on the L.M.S.; so I was able to go down to the Cricklewood sheds occasionally, which helped me considerably, and decided me to give my engine a "5 XP" flavour. Hitherto I had been guided by photographs and my own imagination; for instance, the front of the locomotive is G.W.R., as are also the damper levers and water

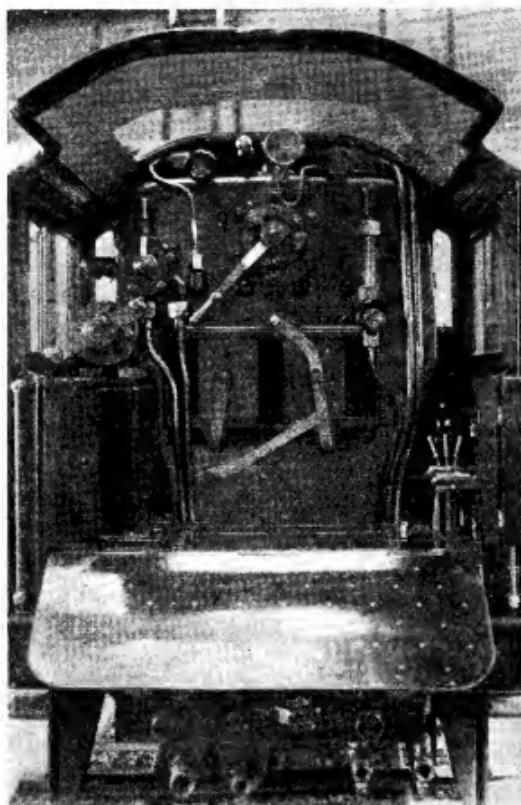


Photo No. 6. Footplate and cab fittings of "Amalgamation"

supply to injector; in fact, the footplate is practically all G.W.R.

Now came the boiler. When war broke out I measured up the material I should want for the boiler and ordered it, because I knew that if I left it very long I should not get it until after the war. When the chassis was finished it was tested with compressed air and I started on the boiler. I was fortunately in the position to have the loan of a machine for rolling the boiler barrel, also an oxy-acetylene welding-plant for brazing, and a shearing machine. I made the formers in  $\frac{1}{4}$ -in. mild-steel plate at my home, but worked the copper around them at my place of employment, as the benches are much more robust and will stand up to the job of forming  $\frac{1}{4}$ -in. copper much better than the one I have in my own workshop; also, the vices are much larger and, of course, stronger. Another reason was that I could anneal the copper much better and quicker.

The fitting of the parts together and preparation for brazing was done in my own workshop, then taken to the works and brazed. There are eighteen  $\frac{1}{2}$ -in.  $\times$  22-gauge fire-tubes and two  $\frac{1}{2}$ -in.  $\times$  20 superheater tubes. These are

after which it was bored a few thou. under  $\frac{1}{8}$  in. and, finally, a  $\frac{1}{4}$ -in. reamer put through held in tailstock chuck, and so on until all the fire-tube holes were finished. The superheater holes were served the same way, except that they were bored  $\frac{1}{8}$  in. so that I could push the button I had made through.

This plate was now placed in position on the firebox tube-plate, lightly clamped and all the holes were scribed through on to the plate. The plates were now parted and all the scribed holes centred, drilled and tapped  $\frac{1}{8}$ -in. Whit. The plates were now placed together again in position, as before, and lightly clamped; four buttons were placed through the front plate and securely fixed by  $\frac{1}{4}$ -in. screws into the already tapped holes. Then the plates were parted again, this time carefully, so as to avoid moving the buttons. The plate, with buttons fixed, was mounted on the lathe faceplate and each button trued by indicator, as before, then bored, screw-cut and a tap held in tailstock put through. When these four holes were finished, I screwed four pieces of  $\frac{1}{4}$ -in. brass rod into them and used these to locate the plates while the buttons were fixed for the rest of the holes. This is a long way

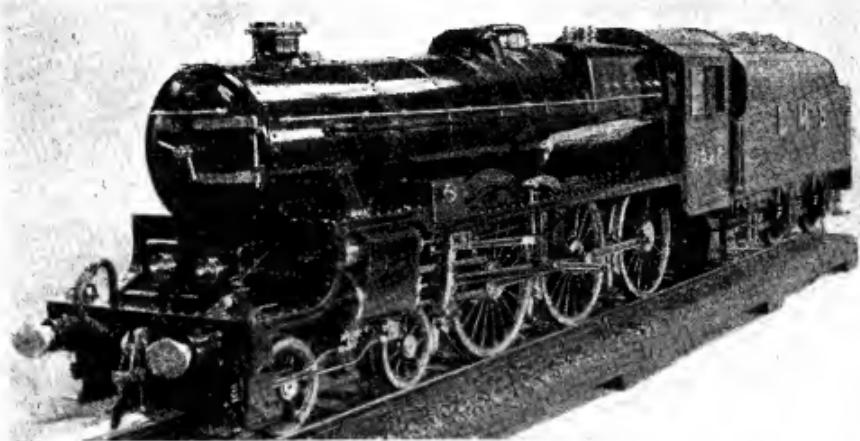


Photo No. 7. "Amalgamation"

screwed into firebox 40 T.P.I., but expanded and sweated at smokebox end. Perhaps the method I used for boring the holes in tube-plates to take these tubes may be of interest. The front tube-plate was set out and lightly centre-punched, and each tube centre was drilled and tapped  $\frac{1}{8}$ -in. Whit. I possessed a set of toolmakers' buttons and, as no doubt most readers know, these are  $\frac{1}{4}$ -in. diameter; I also made two  $\frac{1}{8}$ -in. diameter, and next I turned four pieces of rod to  $\frac{1}{8}$  in. diameter,  $\frac{1}{8}$  in. long, screwing one end of each 40 T.P.I. and chamfering the other. The four toolmakers' buttons were screwed on to the front tube-plate in the position of four tube holes and then fixed to the faceplate; one button was trued up with a dial indicator and finally tightened up on the faceplate and the button removed. A  $\frac{1}{16}$ -in. hole was then drilled,

round to do the job, I know; of course, a pin-drill and drilling machine would do it just as well and much quicker, but I preferred to do it at home and haven't room for a drilling-machine. As regards the firebox end, screw-cutting and just cleaning out with a tap prevents torn threads which are apt to occur in copper.

The superheater tubes were served the same, but I screw-cut the tubes first and then fitted them into the plate, as I had no  $\frac{1}{8}$  in.  $\times$  40 T.P.I. tap.

When I finally measured up my  $\frac{1}{8}$ -in. tubing, prior to cutting to length, I discovered that I was short, and I tried to get more, but was unsuccessful. I was anxious to get on with the job, however, so I extended the firebox into the barrel  $\frac{1}{16}$  in. and just had enough tube. When the boiler was finished it was tested to 200 lb. hydraul-

ically, and 100 lb. steam. The door-sheet is lagged with thin copper and oxydised, and the fittings are "L.B.S.C." pattern.

Although at the beginning this engine was not intended to be an exhibition job, as time went on and it grew, so to speak, I realised that it was worth waiting for THE MODEL ENGINEER Exhibition; so I decided to keep it clean and put a little finish to it.

to it than that; there were the delivery pipes from pump and injector, also the damper-rods. But I have forgotten to mention how I fitted these. First of all, I made a large wood Vee-block and set my boiler barrel in that with the firebox bottom upwards; in other words, the boiler upside down with the firebox end blocked up so that it was level. I then placed the whole chassis in position on the boiler, so that I now had

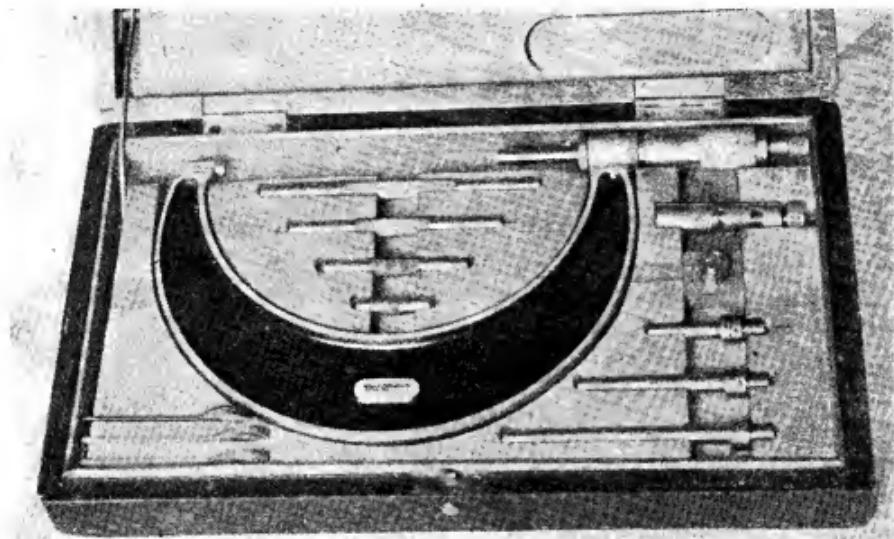


Photo No. 8. Mr. Harris's o-in. to 5-in. micrometer

When ordering the material for the boiler, I forgot all about the chimney and liner, and, as I could not find a suitable piece I was forced to use some odd pieces I had by me. This necessitated making the chimney in three pieces and brazing them together, and the liner was the largest thick-walled tube I had, so I had to make the best of it; that is the reason the chimney is not quite to your liking, Mr. Maskelyne, and also mine! Since the war ended, I have obtained the material to make a new one, but, up to now, have not had the time. I will do so, however, when time permits.

Having tested the engine and the boiler together, the boiler was lagged with 22-gauge sheet brass and the dome and check-valve casings were beaten up from sheet copper, steel formers being made for the purpose. All the boiler projecting into the cab is lagged and oxydised. Then the cab, plating and adornments were undertaken. This job took me quite a while, as I had begun to get quite fussy about its appearance.

When this was finished, I had the painting to contend with, and I wondered whether I should have enough patience for it. I could see no other way then to take the cab top off, uncouple the steam connections in the smokebox and lift the boiler off the frames. There was much more

the whole lot upside down, and made and fitted my damper-rods, as well as the connections to pump and injector, in comfort.

I could see that I should have to do something different from this when painting the engine, so I thought I might as well set about it at this stage and try it out. I had fixed up a very substantial shelf on which to build the locomotive, and this shelf ran parallel with the bench, 2 ft. 8 in. from it; so I purchased two 3 ft. 6 in. lengths of 1½-in. angle-iron, fixed these to one another at the ends and two equidistant places, 5-in. apart; using this as rails to stand the locomotive on, I then placed one end on the bench and one end on the shelf so that I could sit underneath it and use it like a pit. Having taken the boiler off, the chassis was cleaned down thoroughly. This had been painted in between the frames when it was first assembled, but I had to drop the wheels and motion to do the job properly. The boiler had several under-coats and the smokebox was stoved. The boiler had three finishing coats, rubbing down between each coat, and the final coat being polished with liquid metal-polish. My son then lined it, otherwise I am afraid it would not have had any lines at all; it was then polished with Mantis wax.

This was now refitted to the chassis, which  
(Continued on page 40)

# Modifications and Additions to a 10 c.c. Engine

by L. G. Callis

THE following notes and sketches may be of interest to other model engineers who have contemplated making modifications or additions to their existing engines. I had already constructed a Hallam 10 c.c. engine, almost to drawing, when I decided to make another one, with the idea of incorporating a few of the additions, as mentioned in THE MODEL

crankshaft accordingly, the oilways and crankpin being drilled as shown in Fig. 1, after which the crankpin only was casehardened. The finish turning of the mainshaft and the flywheel taper I carried out after hardening, also the cutting of a light spiral oil groove.

The main bearing came next, and I decided to use an old favourite, white-metal, in the form of a

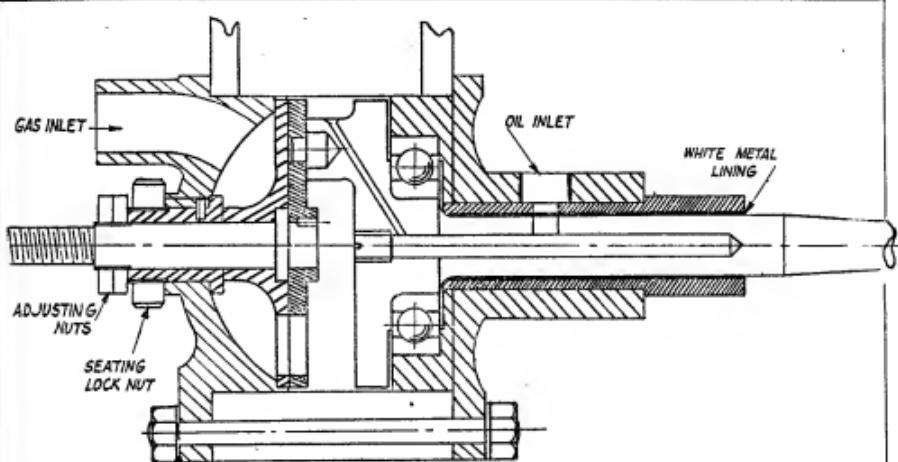


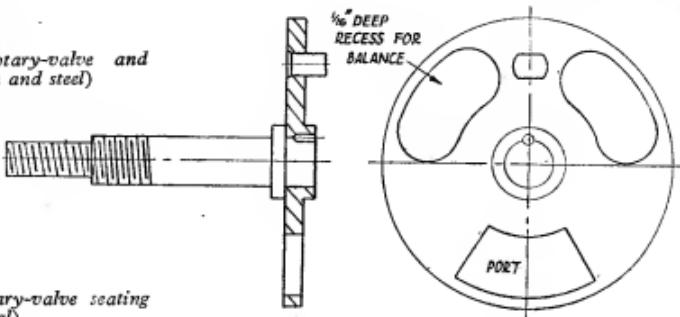
Fig. 1. Sectional view through complete crankcase assembly

ENGINEER by Mr. Westbury, in a series of articles on "Improving the Two-stroke." The first addition that I decided upon, was the use of a rotary valve for the induction, in place of the piston-controlled port, and so I made a wooden pattern for the housing and end cover of this, and obtained a first-class casting from Mr. Hazelgrove of Petts Wood. This casting was machined as shown in Fig. 4. I then machined the rotary-valve seating as in Fig. 3; this item is prevented rotating by a small pin-key. I next machined the rotary-valve disc from a piece of very close grain cast-iron. Recesses are machined in to aid balance, and after cutting the port, and lapping the working face, I fitted it to its spindle, on which it is a light press fit, with a mills key for safety. The outer end of this spindle is threaded to take an internally-threaded worm, for the future addition of an oil pump.

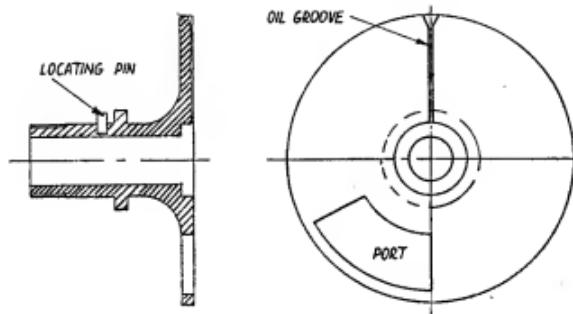
After this, I cut the port in the valve seating, the opening and closing positions approximating very closely to those specified for the "Atom V" engine. Attention was then focused on to the crankshaft, and I decided to fit a  $\frac{1}{2}$  in. diameter bore ball-race. There is plenty of room in the main bearing housing for this, and so I made the

white-metallic bush made as follows: I turned a brass bush  $1/32$  in. plus on the bore size,  $1/32$  in. plus on the outside diameters, and  $\frac{1}{8}$  in. longer than I required. This I tinned internally, and very thinly, with the aid of a piece of  $\frac{1}{8}$  in. diameter copper rod, and while still hot, the bush was placed on to a piece of sheet asbestos, and filled with molten whitemetal. After cooling, the bush was set up in the lathe with the outside diameter running true, then drilled, finish bored and turned at the same setting, and finally parted off to length. This resulted in my having a brass bush with only a  $1/64$  in. thick lining of whitemetal, which is quite ample when one remembers that it has only to wear a few thou. before needing replacement. After I had inserted the bush in the main bearing casting, the oil inlet connection hole was drilled and tapped, and a reamer passed through to remove any burrs. Upon completing these parts, and finishing the other parts of the engine, I assembled the entire set, using just a trace of shellac on all joint surfaces. A pressure-fed float carburettor, of similar construction to the "Atom R," was then fitted, and at this stage a test run was indicated.

Right—Fig. 2. *Rotary-valve and spindle (cast-iron and steel)*



Below—Fig. 3. *Rotary-valve seating (gunmetal)*



In making this test, I experienced very difficult starting, quite an appreciable blowback from the carburettor, and a run of only about 10 sec. Somewhat disappointed, I stripped the engine down, and altered the rotary-valve timing, by machining another keyway in the valve housing; this gave a slightly earlier opening and closing position to the valve port. I then

assembled the engine and tried again. Starting on this occasion was very much easier, and the running period longer, with very little blowback from the carburettor; a test made at this time with a suction carburettor made very little difference to the running. During these tests I used Castrol "R," administered by a spring-loaded syringe oil gun *via* the main bearing and hollow crank. The control of this item proved to be rather touchy and I dispensed with its use in later tests, and used a petrol mixture of 6 : 1.

About this time, the tappet-type contact-breaker appeared in THE MODEL ENGINEER, and so I made one from duralumin, as shown in Fig. 6. Since making the sketch of this component, a damper leaf-spring of 0.010 in. thickness has been added on top of the main spring. Another change I made at this time was the making and fitting of a bigger cylinder-head, also in duralumin, to give a larger cooling area, and a little higher

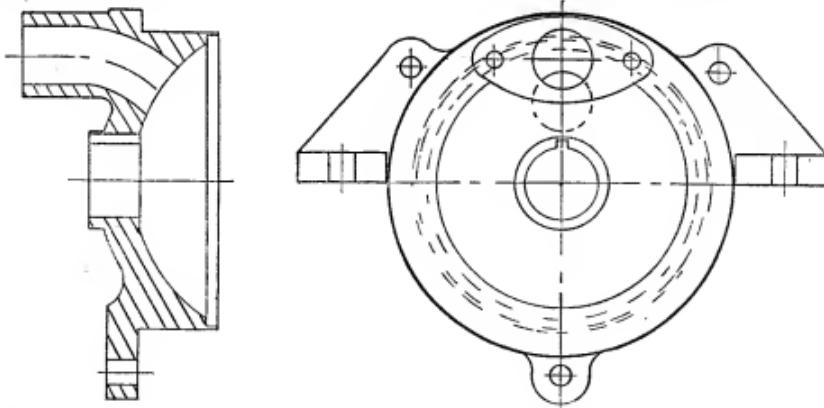
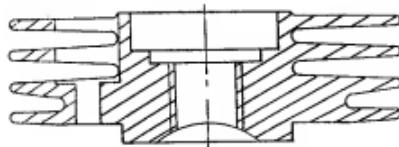
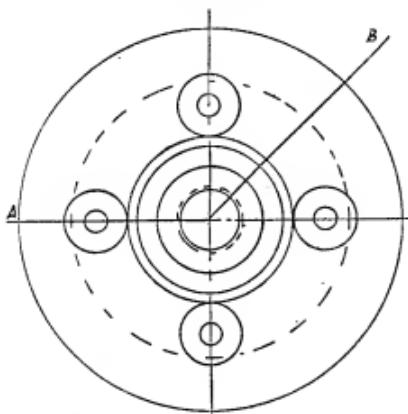


Fig. 4. *Rotary-valve housing and end cover (aluminium)*



SECTION OF CYLINDER HEAD A-B



compression. I also took the opportunity, while the engine was down, of increasing the exhaust port height to a  $\frac{1}{2}$  in., its width by a  $\frac{1}{4}$  in., and the transfer port was also increased in height by  $1\frac{1}{32}$  in. I then put the rotary valve timing back to its original setting, after which I assembled the engine again and decided at this stage to incorporate a "Ken" carburettor. To make the job more interesting, I made a gravity die for the body of this. I also made a casting from this and, on completion of the "Ken" carburettor, I fitted it to the engine, equipping it with pressure feed and an air dashpot for operating the throttle. On testing the engine again, I noted a marked difference all round, starting is very easy, carburettor blowback is almost nil, the engine answers the throttle immediately up or down, and the revs. (not running free) are truly very high. Having no means at my disposal for testing the power developed, I can only say that it is, to my accustomed experience, very considerable. I really think that all the work put into this engine was really a worth-while experience. In conclusion, I should like to say that if any other model engineers requires further information on this conversion, they may obtain same if they will write to me care of the Editor.

Left—Fig. 5. Cylinder-head (duralumin)

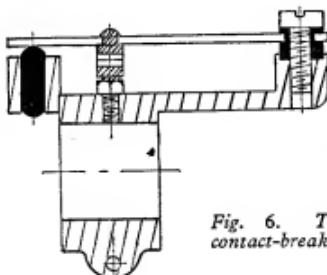
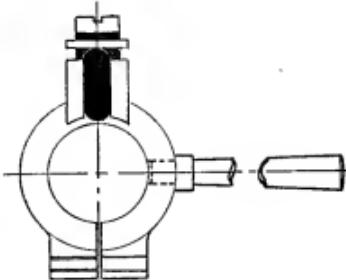


Fig. 6. Tappet-operated contact-breaker (duralumin)



## Concerning Models

(Continued from page 37)

had been painted also, and finally tested under compressed air. This was finished in July, 1942, and occupied approximately 3,000 hours.

We now come to the tender, and as we could get down to the sheds occasionally, it was decided to make it true L.M.S. Dimensions were taken and my son got out a full-size drawing. It was also decided to fit ball-bearings, so a drawing was got out for axleboxes and horn cheeks. I could not obtain any castings, so I made patterns for boxes, horn cheeks and wheels, and was lucky enough to get them cast; I also managed to get six ball-races.

The water tank is 22-s.w.g. copper. Frames are of  $\frac{1}{4}$ -in. mild-steel and the body  $\frac{1}{8}$ -in. mild-steel. All the rivet holes round the body are

$\frac{1}{16}$  in., and were drilled with a hand-brace. The brakes and hangers are constructed in the same way as on the locomotive, and are operated by either steam or hand.

During the years occupied in the construction of this model I have done several other jobs; one of them might be of interest to readers. This is some additions to a micrometer from 0 to 4 in. When I bought it, its range was from 4 in. to 5 in., so I made the necessary parts for adapting to read from 0 in. to 4 in. including the test-bars and case. It is illustrated in Photo No. 8.

In conclusion, I would like to thank "L.B.S.C." for his very helpful advice, and my son for the majority of the photographs and illustrations for this article.

# IN THE WORKSHOP

by "Duplex"

## 28—Cross-Drilling

CROSS-DRILLING, or radial drilling as it is sometimes called, is the operation of drilling a hole accurately through the centre of a shaft or other part of circular cross-section; and although, at first sight, there may appear to be little difficulty in doing this, it is surprising the number of instances encountered, even in commercial work, where a hole intended to be radial is drilled tangentially. In the production field there should be little excuse for inaccuracy in this respect, as proprietary jigs are obtainable that ensure accurate drilling, provided that

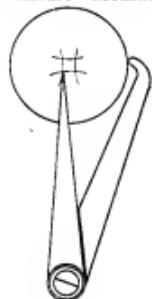


Fig. 1



Fig. 2

simple instructions are carried out to prevent faulty alignment of the work due to the accumulation of swarf.

In the small machine-shop, more often than not, a single component has to be drilled in this way, and more time may be taken in setting up the work correctly than is expended in the actual drilling operation. It is, however, with operations on a small scale that we are primarily concerned, rather than with the methods used in repetition work.

In the first place, it will be advisable to consider the methods that can be employed when using only the simple equipment generally found in the small workshop; then, rather more elaborate methods will be described in which guides or simple jigs are used that will save time and ensure accuracy without resort to any marking-out operations; finally, instructions will be given for making a cross-drilling jig suitable for dealing with the large variety of work commonly encountered in the small workshop.

### Cross-Drilling from Marked-Out Centres

The procedure, here, is to mark-out the position of the hole, and, after the work has been set truly in the machine vice or clamped in a V-block, the hole is drilled in the ordinary way in the drilling machine.

The end of the shaft and a portion of its

length is painted with marking fluid and, as shown in Fig. 1, the centre of the shaft is marked-out with the jenny callipers. The distance of the hole centre from the end of the shaft is then marked-out in a similar manner as depicted in Fig. 2.

The work is next transferred to a V-block resting on the surface plate, as represented in Fig. 3; and when the point of the scribe of the surface gauge has been set to the centre of the shaft as previously determined, a line is scribed right across the end of the shaft and along its surface to cut the scribed distance-line.

The next step is to make a centre-punch mark at the intersection of the two scribed lines to indicate the location of the hole centre and to form a guide centre for the drill.

As some workers appear to have great difficulty in accurately punch-marking the point of intersection of two scribed lines, some hints on this procedure based on practical experience may prove helpful. In the first place, a small centre-punch with a really sharp point formed to an included angle of about 60 deg. is used to make the initial marking; this is followed by a punch with a 90 deg. point to form the drilling centre. Where the lines are only lightly scribed, the

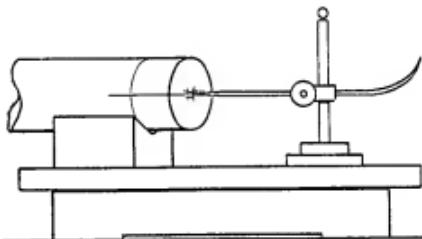


Fig. 3

punch point can be more accurately located with the aid of a lens, but if the scribing marks are more deeply formed, the punch point can be engaged in one of the lines and then carefully slid along until it is felt to drop into the cross-line, perhaps even with a faint click. A word of warning is, here, necessary, for if an attempt is made to cut deep grooves with the scribe, inaccurate marking-out is almost certain to result.

Nevertheless, if the scribe point is really sharp, it will readily cut a line with very little applied pressure sufficiently deep to guide the point of a properly sharpened centre-punch, provided, of course, that the operator has a delicate sense of touch.

When the punch point is accurately located and the punch itself held truly vertical, a single, light hammer blow is given to the base of the punch.

A single blow is advised, as a succession of blows may cause the punch to jump and make more than one marking.

The punch mark so made is then carefully examined, preferably with the aid of a lens if its exact location is important, in order to make sure that the cross-lines pass through the exact centre of the mark. Should the punch mark be found to be out of place, it can, of course, be corrected by inclining the punch and again striking it, although it is essential that the final mark should be made with the punch held vertically.

This drawing-over, as it is termed, will be inevitable if an error has been made, but it is well worth taking considerable trouble at the outset in order to avoid having to make any subsequent corrections.

The next step is to clamp the work in a V-block or in the machine vice resting on the surface plate, and at the same time to set the scribed centre-line exactly vertical with the aid of a square also standing on the surface plate.

The work, while securely held in this position in the V-block or vice, is now ready for drilling in the drilling machine.

In the first place, the punched centre-mark is enlarged by means of a centre-drill to form a guide seating for the point of the drill which

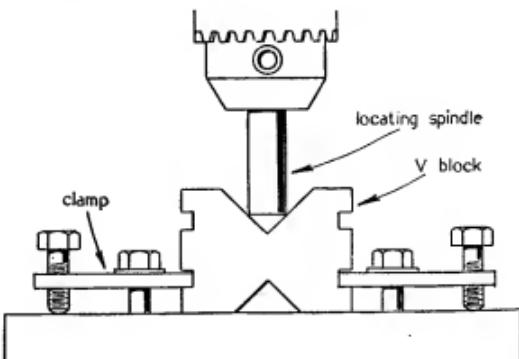


Fig. 4

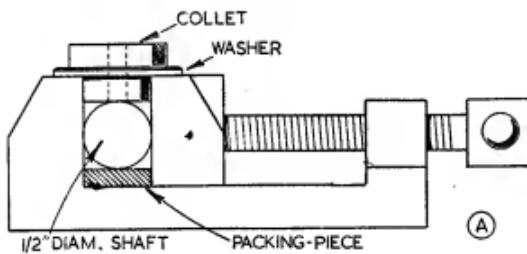
adequate guidance, and the drilling operation will be as readily carried out as though on a flat surface.

#### Setting the V-Block for Cross-drilling

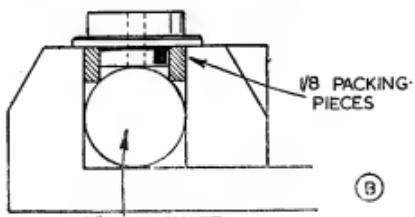
A quick method of cross-drilling, sometimes used, is to clamp the V-block to the drilling-machine table so that the block is correctly aligned with the axis of the drilling-machine spindle.

As shown in Fig. 4, the V-block is located by means of a short, rigid piece of round material held in the drill chuck.

This method suffers from the disadvantage that the drill at starting has no centre-mark to guide its point, and, in addition, the drill point encounters a curved surface which tends to deflect it from the true axial path; nevertheless, if the smallest size of centre-drill is used, the drill spindle is a good fit in its bearings, and if only light drilling pressure is applied, good results can be obtained.



Ⓐ



Ⓑ

Fig. 5

follows. For this purpose, it is advisable to use a small centre-drill with a body of  $\frac{1}{8}$  in. diameter and a  $3/64$ -in. drill point; this is followed, where necessary, by a larger centre-drill in order to form a recess at least equal in diameter to that of the drill employed for drilling the cross-hole.

In this way, the point of the drill is afforded

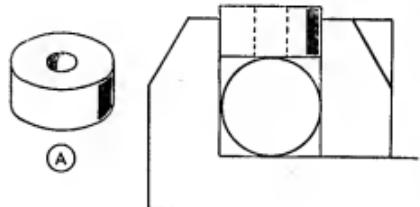


Fig. 6

#### Drilling Guides

Accurate cross-drilling is greatly facilitated when a guide of some form is employed to locate the drill point in correct relation to the work and to support the drill throughout the drilling operation. The simplest method, perhaps, and one requiring no additional equipment, is to use the ordinary die-holder guide collets of the Card

pattern in conjunction with the machine vice. These collets, which in the small size have a register portion  $\frac{1}{8}$  in. in diameter, are bored with guide holes of from  $3/32$  in. to  $\frac{1}{16}$  in. in diameter and also with B.A. size clearance holes of from No. 0 to No. 8. The larger sized collets are furnished with a register  $\frac{1}{4}$  in. in diameter and with bores of from  $\frac{1}{4}$  in. to  $\frac{1}{2}$  in.

Fig. 5 shows the manner in which the small size collets are used when drilling shafts of various diameters, but it is advisable to insert pieces of thin card between the components and

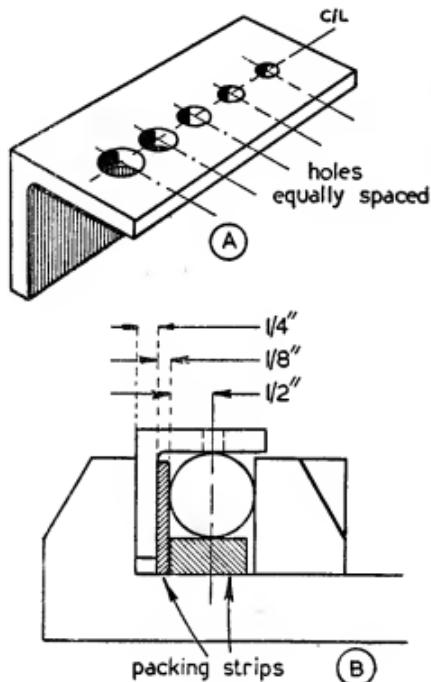


Fig. 7

the vice jaws to allow for any slight discrepancy in the diameter of the parts, and thus ensure equal and secure clamping pressure.

A thin washer should be placed under the head of the collet to prevent it tipping in the vice jaws, and, where necessary, the shaft is raised on a packing-piece to bring its upper surface close to the underside of the collet, in order to provide support for the drill as near to its point as possible.

The position of the hole from the end of the shaft can be adjusted by moving either the collet or the work itself; this distance is readily determined with the aid of a narrow rule by taking a measurement from the collet register to the end of the shaft, and then adding to this half the diameter of the register. Clearly, this way of setting up the work with die-collets when cross-

drilling, although invaluable at times, is apt to be rather tedious and slow, especially when several packing-strips have to be employed; one of the following ways of guiding the drill may, therefore, be preferred.

A method commonly employed in the small

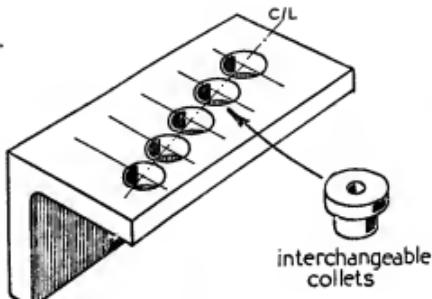


Fig. 8

machine shop is to turn a collar to the exact external diameter of the work, and then to drill centrally to form the guide hole for the drill, as represented in Fig. 6A. This collar, together with the shaft, is then gripped in the machine vice in accordance with Fig. 6B.

To prevent the collar tipping, it should be made of sufficient thickness to ensure that it will align itself horizontally when gripped by the vice jaws.

An efficient cross-drilling guide can be made from a piece of angle material machined true on all its faces and provided on its upper surface with either a series of holes of varying size, or with a number of holes to take the die-collets at different distances from the centre-line. The first form, illustrated in Fig. 7A, is adjusted centrally on the work by means of packing strips, as shown in Fig. 7B; here, a shaft of 1 in. diameter is set with an  $\frac{1}{8}$ -in. packing-piece to bring its centre in line with the row of holes in the guide, and, after the necessary adjustments have been made, the components are firmly secured between the jaws of the machine vice. When

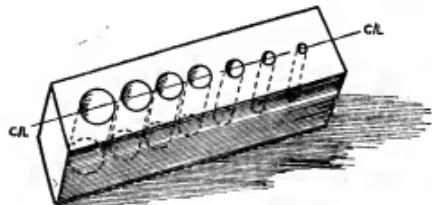


Fig. 9

making these jigs, the guide holes should be accurately spaced from the end face so that a rule can be used to set the distance the hole is drilled from the end of the shaft.

In the second example, as shown in Fig. 8, the holes in the jig are all drilled of equal size to

take a die-collet, but they lie at varying distances from the centre-line in order to accommodate shafts of several sizes without the use of packings. The size of the guide hole in this case is altered by merely changing the collet.

As in the previous instance, the work should, where necessary, be raised by means of a packing-strip to bring it up to the jig.

Some mechanics prefer to use a flat bar of the pattern illustrated in Fig. 9 for cross-drilling operations; and although this type of guide will make contact with the upper surface of the work, packing-strips must be employed, as in the case of the collet shown in Fig. 5, to enable the jig and the work to be gripped simultaneously in the vice. As in the two previous examples, this form of jig can either be furnished with

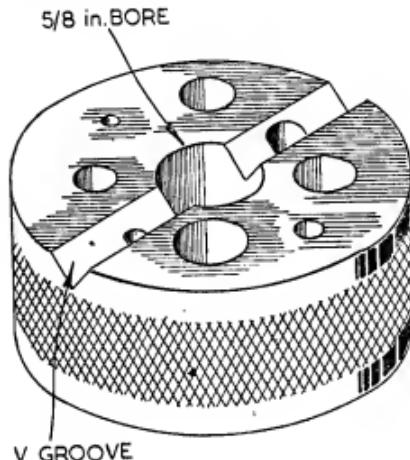


Fig. 11

a series of guide holes of varying size, or a hole, or holes, to accommodate die-collets can be provided. In the small workshop, where these drilling jigs are used from time to time only, it is hardly necessary to harden or case-harden the material composing the guide surfaces, provided that sufficient thickness of metal is allowed in order to resist undue wear.

#### Cross-drilling Jigs

So far, only improvised cross-drilling devices have been considered; that is to say, components used in conjunction with a V-block or with the ordinary machine vice serving the drilling machine. Next in order are the true drilling-jigs, which are self-contained appliances specially adapted for the purpose of cross-drilling.

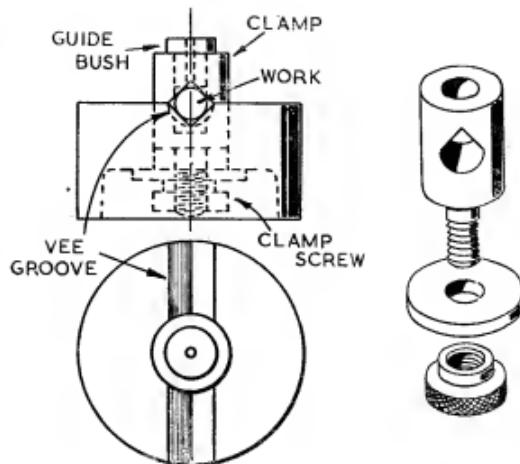


Fig. 10

Fig. 10A

The commercial jig, illustrated in Fig. 10, was originally made with the rectangular head of the clamp-bolt drilled with a series of guide holes of different sizes, but the device has since been modified, as represented in the drawings in Fig. 10 and 10A, and a clamp-bolt with a cylindrical head is now fitted. As will be seen, the head of the central clamp-bolt is bored axially to accommodate guide-bushes having drilling holes of different sizes.

The action of the clamp-bolt is to draw the work downwards and thus centralise it in the V-

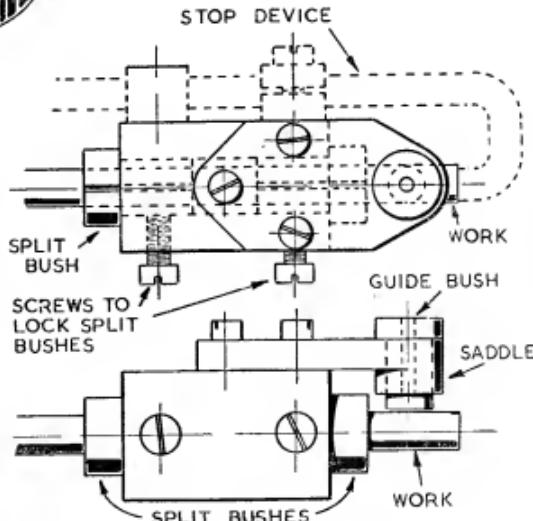


Fig. 12

groove machined in the base of the appliance. The Starrett bench block No. 129, illustrated in Fig. 11, which is accurately machined and surface-ground after hardening, could, without difficulty, be adapted to make a drilling jig of this pattern. The central hole is bored  $\frac{1}{2}$  in. in diameter and lies on the axis of the V-groove machined on the upper surface of the block. Moreover, the recess in the under side of the base would provide ample

alternative method of preventing the base-block tipping, would be to mount it on a soleplate, and a raising screw with a swivel head, after the manner of a screw-jack, could then be fitted to this plate to support the work from below.

As an example of the more elaborate type of cross-drilling jig intended for commercial use, the Bridson bar-jig is illustrated in Fig. 13. This appliance is manufactured as a precision tool,

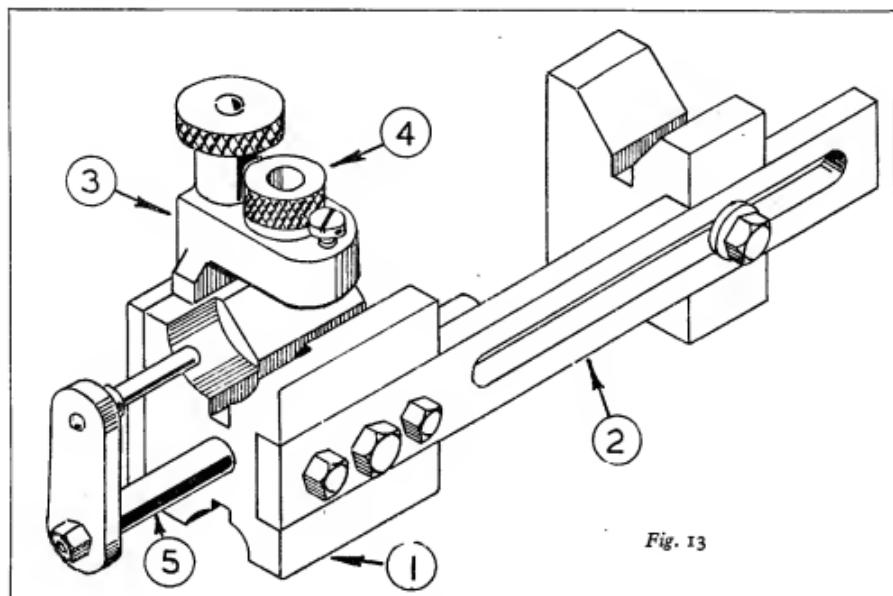


Fig. 13

space for housing the nut and washer fitted to the central clamp-bolt.

Another variety of drilling jig is illustrated in Fig. 12; here, the rectangular base-block is bored axially to accommodate a bush at either end for locating and clamping the work. These bushes are split, so that when the clamping-screws shown are tightened, the work is securely held. A set of duplicate bushes will, of course, be required for holding work of various diameters.

On the upper surface of the block, a bar or saddle is mounted, which is bored to receive the removable bushes used to guide the drill. As indicated in the drawing in broken lines, a work stop can be readily fitted to enable a cross-hole to be drilled at an exact distance from the end of a shaft.

It will probably be remarked that the overhang of the work beyond the bearing surface of the base will cause the jig to tip and the work to bend when the drilling pressure is applied; this is certainly a weak point in the design and could be overcome by using a packing-block between the drill-table and the overhanging end of the work; but if several parts are drilled in this way, care must be taken not to allow an accumulation of swarf to interfere with the height adjustment. An

and its necessarily high cost would, of course, militate against its use in the small workshop; nevertheless, a short description of the device will serve to draw attention to some of the features embodied in the design of a high-class drilling jig.

The large V-block (1), which is reversible on the extended bar (2) to accommodate both large and small work, carries the drill bar (3) in a screw-actuated slide that both secures the work in place and houses the guide collet (4). A graduated stop-bar (5) for locating the work endwise is fitted to the V-block and is secured after adjustment by a clamp-screw.

As will be seen, the slotted bar (2) carries a second smaller V-block that can be adjusted as required to give additional support when drilling long shafts.

The capacity of the jig covers a range of from  $\frac{1}{2}$  in. to  $2\frac{1}{2}$  in. diameter work, and a full set of standard guide-collets up to  $\frac{1}{2}$  in. bore is available.

A full description of how to make and use a simple form of cross-drilling jig will be given in the continuation of this article, and, in addition, the methods employed for cross-drilling and cross-boring in the lathe will be considered.

(To be continued)

# A 3½-in. Gauge L.M.S. Class 5 Loco.

by "L.B.S.C."

THE full-size L.M.S. "Class 5" engines have a regulator in the dome, arranged horizontally. The top of the casting is faced off, and has three main ports. There are two valves; a bronze one containing main ports and a small starting port, and a cast-iron one sliding on top of the main one. When the driver moves his handle up, the upper valve first slides on the lower one and uncovers the starting port; then the actuating pin moves the main valve as well, and uncovers the big ports. The regulator I am specifying for "Doris" is a simplified edition of this. Instead of two valves and multiple ports, we have one valve only, and a single port with a little triangular bit cut out of one edge, so that this is uncovered first, and acts as a starting port. The actuating levers are small editions of the full-size article, arranged in much the same way.

## Stand or column

Castings complete with bosses and brackets, should be available for the stand or column. If not, use a bit of brass bar,  $\frac{1}{2}$  in. by  $\frac{1}{8}$  in. section, faced off each end to a length of  $1\frac{1}{8}$  in. Two pieces of  $\frac{1}{4}$ -in. by 16-gauge angle,  $\frac{1}{2}$  in. long, can be attached to the upper part by brass screws, or silver-soldering, for the brackets supporting the regulator. Drill a  $3/32$ -in. hole about  $\frac{1}{8}$  in. deep, at the location of the bosses on opposite sides of the stand, and make the bosses from  $\frac{1}{4}$ -in. and  $\frac{1}{8}$ -in. brass rod. Leave a little pip on the end of each, about  $3/32$  in. long, and a tight fit in the holes.

In the upper end of the stand, cut a rectangular port as shown, making it about  $\frac{1}{16}$  in. deep. If end-milled, as described in these notes for ports in slide-valve cylinders, leave the ends rounded; it doesn't matter whether they are round or square. If you cut the port by drilling and chipping, squared ends are easier to form. On the underside, make two centre-pops a full  $\frac{1}{8}$  in. apart,  $\frac{1}{8}$  in. from the side carrying the large boss; then drill two  $\frac{1}{4}$ -in. holes running the length of the column, and well cutting into the port (see underside view). At  $9/32$  in. from the top of the column, on the centre-line of the wider side, drill a cross hole with No. 13 drill, cutting right across the two  $\frac{1}{4}$ -in. holes, and slightly countersink each end. In this is fitted the bush carrying the spindle for the two levers operating the valve. Chuck a piece of  $\frac{1}{16}$ -in. round rod, bronze for preference, but brass will do; face, centre, and drill down about  $\frac{1}{8}$  in. depth with No. 32 drill. Part off at  $\frac{1}{8}$  in. from the end; rechuck, and poke a  $\frac{1}{8}$ -in. parallel reamer through. Squeeze this into the cross hole. Cut out a little plate from 16-gauge brass or copper, to cover up the two holes in the base, attaching same by a single brass screw; then silver-solder the lot, if the stand has been built up. If a casting has been used, only the bottom plate and the bush will need this attention; see that

the silver-solder fills up the countersinks around the bush.

Centre-pop the bigger boss, drill  $9/32$  in., cutting well into the two  $\frac{1}{4}$ -in. holes, and tap  $\frac{1}{8}$  in. by 40 for the steam pipe. Drill a No. 30 hole in the little boss, about  $\frac{1}{16}$  in. deep, for the end of the regulator-rod; take mighty good care not to pierce the  $\frac{1}{4}$ -in. holes.

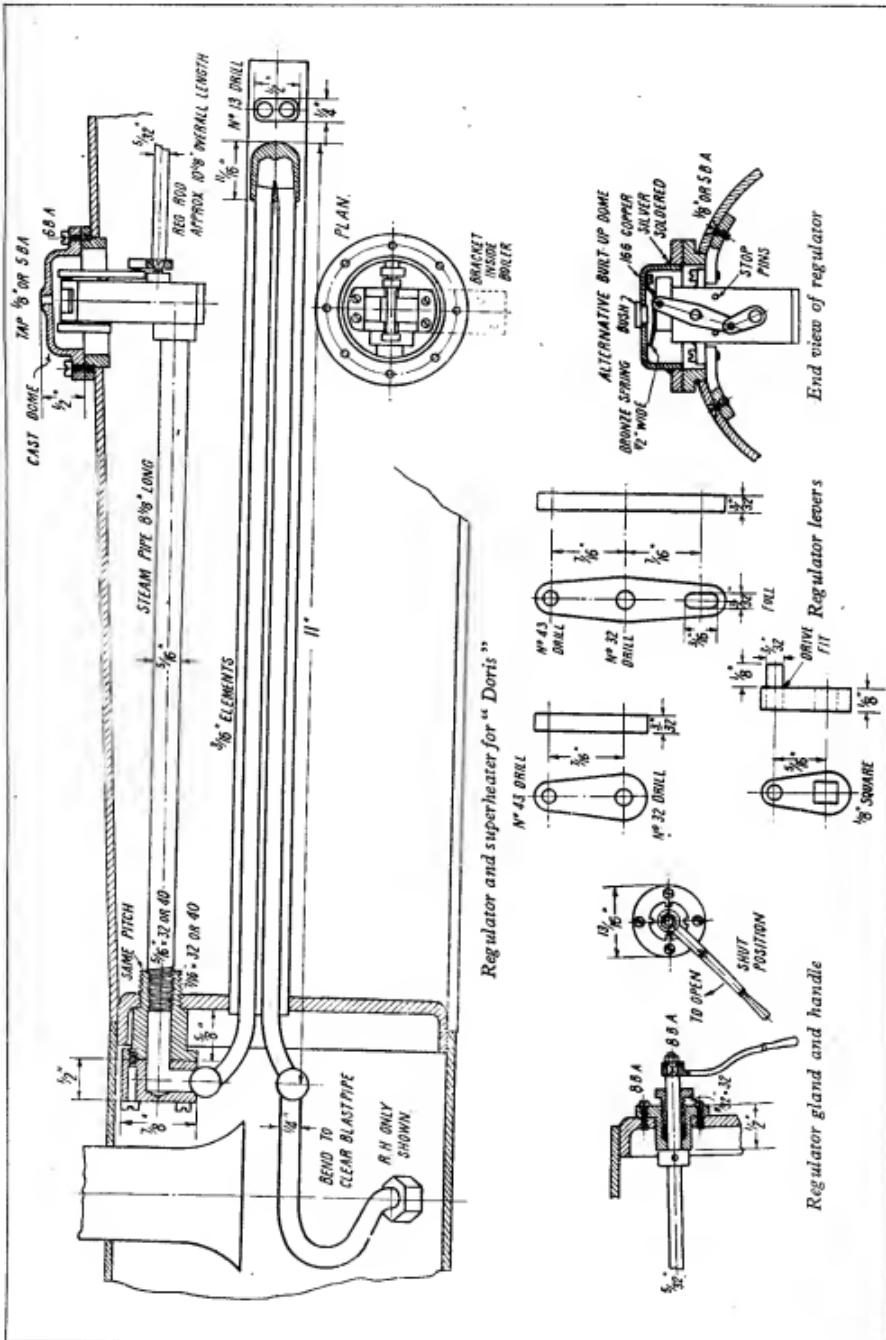
## Regulator valve

The valve can be made either from a casting, or a piece of bronze or hard brass bar,  $\frac{1}{2}$  in. wide,  $\frac{1}{8}$  in. thick, and  $\frac{1}{2}$  in. long. The middle part must be milled out longitudinally, leaving a sort of wall at each side, like a glorified axlebox flange (see sectional illustration). If the piece of metal is clamped under the slide-rest tool-holder, lying on its edge, you can take out the centre with an end-mill or slot-drill in the three-jaw. Right in the middle, cut a port  $\frac{1}{8}$  in. wide and  $9/32$  in. long. Note, this is rectangular, no fancy bits cut out of the edge. Cut a U-shaped slot a full  $\frac{1}{8}$  in. deep, right across both side walls or flanges; this should just admit a piece of  $3/32$ -in. bronze or rustless steel rod or wire. Face off both the valve and the port face, same as I described for slide-valve cylinders.

## Levers and assembly

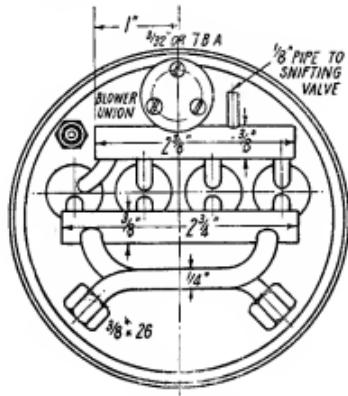
The levers are simple filing and drilling jobs, the double-armed one and its one-armed mate being made from  $\frac{1}{8}$ -in. by  $3/32$ -in. strip, and the one carrying the pin from  $\frac{1}{8}$ -in. by  $\frac{1}{8}$ -in. material. Use either bronze (phosphor or nickel) or good hard brass. Beginners note—to cut the  $\frac{1}{8}$ -in. sq. hole clean, first drill it No. 32 and then drive a square punch through. This is merely about  $2$  in. of  $\frac{1}{8}$ -in. sq. silver-steel, squared off truly at one end, and bevelled off at the other. Harden and temper the squared end to dark yellow. The bevelled end, when hit by the hammer, won't burr sufficiently to prevent the punch being driven clean through the hole. I have a little cast-iron block with various sizes of holes in it; the article to be punched is placed over an appropriate-sized hole, and the punch driven right through, the result being a clean hole with sharp corners. Drill the hole for the pin No. 43, and squeeze in a pin made from  $3/32$ -in. rustless steel or hard bronze.

Assembling the regulator is only a few minutes' work. The spindle is a  $\frac{3}{16}$ -in. length of  $\frac{1}{8}$ -in. round rustless steel or bronze, and the valve-pin a  $\frac{1}{8}$ -in. length of  $3/32$ -in. ditto. Squeeze one end of each into the longer lever. Put the valve in mid-position. Poke the spindle through the bush in the stand, the valve-pin going through the two U-slots in the valve at same time, then press the shorter lever on the other end. See that the two levers are exactly parallel, then fit a weeny key in each end of the spindle, as shown by the black dot in the end view of regulator erected. If the



levers are a *real* press fit on the spindle, these keys are not necessary; but if fitted, bits of domestic pins would do quite well, or bits of brass wire of equal diameter. I use blanket pins for jobs like these; a No. 57 drill makes a hole which takes the microscopic key a drive fit. Alternatively, 12-B.A. brass screws could be used, the drill size for which is No. 62.

Two stop pins are required; these are merely screwed stubs of  $\frac{1}{16}$ -in. hard brass or bronze wire. They are shown in the end view. Move the valve so that the port is fully open, then drill a No. 55 hole alongside the lever, tap  $\frac{1}{16}$  or 10-B.A., and screw in the wire stub. Then shift valve until port is completely closed, allowing a little for overlap. The position will be approximately that shown in the end view, the valve having a travel of  $\frac{1}{4}$  in. from fully-closed to full-open.



Headers and connecting pipes

Fit another stop-pin as above, and Bob's your uncle.

#### How to erect the regulator

Two brackets are needed to carry the stand, as in full-size practice. They are made from 1-in. lengths of  $\frac{1}{4}$ -in. by  $\frac{1}{4}$ -in. brass, bent as shown in the end view and are attached to the boiler by two  $\frac{1}{4}$ -in. or 5-B.A. countersunk brass screws in each. Drill two No. 30 holes in the boiler shell, at each side of the dome-ring, as shown by dotted lines and circles in the plan view; then hold the brackets in position whilst the location of one hole is marked on each with a scribe. Remove, drill No. 40, tap  $\frac{1}{16}$ -in. or 5-B.A., replace, put a screw in each, adjust brackets for parallelism then locate the other screw-hole with a No. 30 drill put through the other hole. Follow with No. 40, tap, and put the other screw in. File flush with boiler shell, and solder over, to ensure absence of steam leakage; the screws won't have to come out any more. Drill the holes in the brackets of the regulator stand, as shown in underside and plan views; put the regulator in position, and secure with four 3/32-in. or 7-B.A. brass screws.

As the operating-gear for this regulator is precisely the same as that just recently described

for "Maid of Kent" and "Minx," except for being a little smaller, and needing no stop on the spindle, there is no need to detail out the whole of the rigmarole again; so I'll just run through it, giving the variations in sizes. The flange and stuffing-box is either turned from a casting, or from brass rod  $\frac{13}{16}$  in. diameter or larger, drilled No. 21 for the rod, and drilled and tapped  $\frac{9}{32}$  in. by  $\frac{3}{32}$  for the gland, which is made from  $\frac{1}{16}$ -in. rod. The collar on the spindle is merely to prevent end-play, and does not act as an "open-and-shut" stop. The regulator-rod is a piece of 5/32-in. bronze rod approximately  $10\frac{1}{2}$  in. overall length. One end is turned to  $\frac{1}{2}$  in. diameter for  $\frac{5}{32}$  in. length, to fit in the boss on the stand, and a  $\frac{1}{2}$ -in. square is filed on it immediately behind, to accommodate the short lever with the pin in it. The other end is turned down and screwed 8-B.A., and squared for the regulator handle, which should be L.M.S. type as shown in the illustration; I make similar handles by using a piece of round nickel-bronze, turning the grip, and filing or milling the flat part. The boss is made from round bronze and silver-soldered to the lever.

Put the collar on the regulator-rod approximately  $\frac{7}{8}$  in. from the square at the handle end; then insert in boiler through the  $\frac{1}{2}$ -in. hole in backhead. Hold the actuating lever behind the regulator stand with a pair of long-nosed pliers, the pin on same engaging with the slotted hole in the bottom of the long lever. Put the end of the rod through the square hole, entering the spigot into the small boss on the stand. Now put the flange fitting on, and press against backhead. If the rod has about  $\frac{1}{64}$  in. end-play, the position of the collar is correct; if more, or if no end-play at all, collar needs adjustment. When you have found the right position, pin the collar to the rod, same as "Maid" and "Minx," and attach the flange fitting to the backhead by four 8-B.A. brass screws, putting a  $1\frac{1}{64}$ -in. "Hallite" or similar gasket between the contact faces. Pack the gland with graphited yarn, put on the handle, and that's that. When the regulator is shut, the handle should be in the position shown; pushing it up, opens the valve.

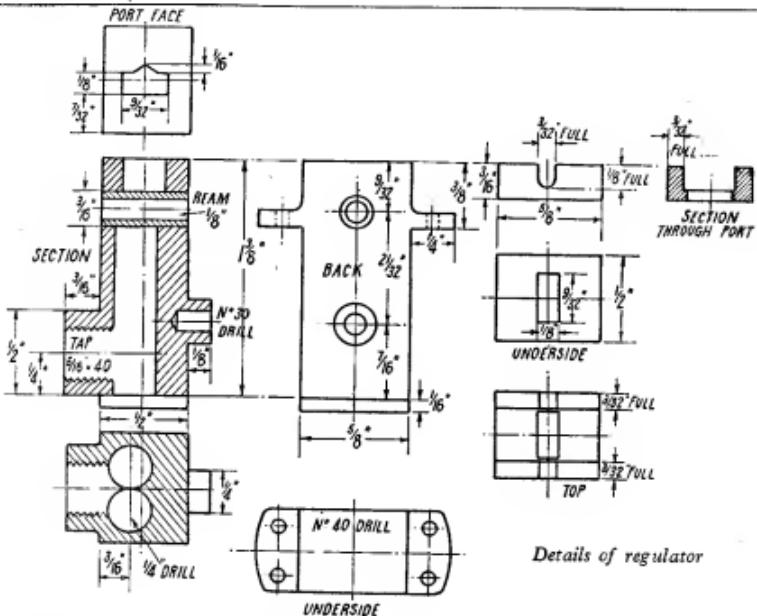
#### Cover for Dome-bush

The cover may be cast or built up. If cast, it simply needs the flange facing off and turning to diameter; there will be a chucking-piece cast on for holding it. Then reverse in chuck, and part off the chucking-piece, facing same almost flush with the cover. Drill No. 40 and tap  $\frac{1}{4}$ -in. or 5-B.A. for a screw; this provides a ready means of oiling the valve. Lack of lubrication is the chief cause of leaky throttles.

To make a built-up cover, turn up a copper or bronze ring,  $1\frac{1}{2}$  in. diameter, with a  $\frac{1}{16}$ -in. hole in it; thickness about  $\frac{1}{8}$  in.; see instructions given for "Maid" and "Minx." Knock up a copper cup from 16-gauge sheet metal; round off the end of a bit of  $1\frac{1}{8}$ -in. rod to shape required, to act as a former, cut out a disc of copper approximately 2 in. diameter, and proceed as described for the smokebox tubeplate. Set the cup in the ring, so that the overall height is a shade under  $\frac{1}{2}$  in.; fit a weeny bush, tapped  $\frac{1}{4}$ -in. or 5-B.A., in the top, silver-solder the lot,

and face off any of the cup projecting below the flange. The flanges of either cast or built-up covers should have eight No. 34 holes drilled in them ; and the cover is then fitted to the bush on the boiler, by eight 6-B.A. brass screws, in the same manner as you would fit a cylinder cover. Put a  $1/64$ -in. gasket between the flanges.

the tubeplate flange. It can be made from a casting or a piece of  $1/2$ -in. round or hexagon brass rod chucked in three-jaw. Face, centre, drill  $9/32$  in. for  $1\frac{1}{8}$  in. depth, tap  $1/8$  in. by 32 or 40 for  $1/4$  in. depth ; turn down  $1/8$  in. length to  $1/8$  in. diameter, further reduce  $1/8$  in. length to  $1/16$  in. diameter, and screw  $1/16$  in. by 32 or 40, same pitch as inside



By the good rights, the pressure of steam should keep the regulator valve on its face, same as it does an ordinary slide-valve ; but to prevent the valve unseating when the engine is turned upside down for any purpose, and to avoid same when the engine is cold, a flat spring of thin bronze strip  $1/16$  in. wide, such as used for dynamo and motor brush springs, may be attached to the inside of the dome cover by a brass screw. This is shown slightly exaggerated in the end view. Note, the spring must press on the flanges or walls of the valve, and not in the recess, or it will obstruct the port ; and a small hole should be drilled in it, to allow oil to drop through on to the valve.

### Superheater

The superheater is another component which only differs from that described for "Maid" and "Minx" in the sizes of the parts, and the connection to the cylinders ; so the same details of construction are applicable. Owing to the reversed-flange smokebox tubeplate, there is not much room available between the hole in the tubeplate, and the flange ; so, in order to get in a decent-sized flange for the wet header, I have shown the part which screws on to the steam-pipe, of extra length, the contact face being right clear of

thread. Part off at 1 in. from the end, reverse in chuck, and take a cleaning-up skim off the contact face.

The steam-pipe is a piece of 20-gauge copper tube  $1/16$  in. diameter and  $8\frac{1}{2}$  in. long. One end is screwed 40 pitch for about  $1/8$  in. length, to suit the boss in the regulator stand ; the other is screwed about  $1/2$  in. length, to the pitch used for tapping the header fitting. Put a smear of plumbers' jointing on the threads, screw the steam-pipe home in the stand, through the hole in the tubeplate, by aid of a round file stuck in the end, then fit the flange as described for "Maid" and "Minx." The header itself has a flange made from a  $1/2$ -in. slice of  $7/8$ -in. round rod ; the cross-tube is  $1/8$  in. diameter, and is let into a recess filed across the flange. The four elements are made from  $1/8$ -in. by 22-gauge copper tube, and the block return-bends from  $1/8$ -in. lengths of  $1/8$ -in. by  $1/8$ -in. copper bar. Don't forget, brother beginners—these must be either brazed or Sifbronzed to the elements, *not* silver-soldered. They are too close to the fire for silver-soldering to be safe. We use *really* hot steam, for economy and efficiency ; not the kind that comes out of the scullery copper on washing-day ! Silver-soldering is, however, quite in order for the joints in the smokebox. The hot header is a  $2\frac{1}{2}$ -in.

length of  $\frac{3}{8}$ -in. copper tube 22-gauge, with four No. 13 holes drilled in it at  $\frac{1}{8}$  in. centres, for the ends of the elements. Two  $\frac{1}{4}$ -in. holes are drilled about  $\frac{3}{8}$  in. from the ends, for the two steam-pipes leading to the cylinders. If these are crossed, as shown in the view of the smokebox tubeplate with superheater in position, it will make the job of connecting up, ever so much easier, when the boiler is finally erected on the frames.

The superheater is assembled the same way as described for "Maid" and "Minx." First braze the return-bends to the elements, as mentioned previously; plug the ends of the wet and hot header pipes with discs of 16-gauge copper. Tie the wet header pipe with thin iron wire to the circular flange in the position shown, off-set to clear the blower union; and don't forget to drill the hole in it, to allow steam to pass in from the flange. Mistakes are easily made! Insert the elements in the holes in the header tubes; they should "stay put" if the holes are drilled No. 13. Make up the two steam-pipes

from  $\frac{1}{4}$ -in. tube, about 22-gauge, fitting a union nut and cone on the end of each, a process described many times already. Make the nuts from  $\frac{1}{8}$ -in. or  $\frac{1}{4}$ -in. hexagon brass rod, and tap them  $\frac{1}{8}$  in. by 26. Allow about 6 in. of  $\frac{1}{4}$ -in. copper pipe for the sniffling-valve connection (this will be described with the other fittings). Fit the steam-pipes to the hot header, then silver-solder all the joints at one heat. My favourite material for jobs like this, is Johnson Matthey's B6 alloy, but "Easyflo" or best grade ordinary silver-solder, will be quite all right. When you are quite sure there are no missed places—very important that!—pickle, wash, and be sure to let the water run well through the whole lot, to get rid of any internal scaling that has taken place in the silver-soldering process. You don't want it wandering down into the piston-valves! Drill and tap the holes in the circular flanges, for the fixing-screws, but don't erect the superheater permanently until the boiler is complete with all the other fittings, and ready for mounting on the chassis.

## For the Bookshelf

**Newnes Television Manual** (fifth edition), by F. J. Camm. (London : George Newnes Ltd. ; Tower House, Southampton Street, W.C.2.) Price 7s. 6d. net.

This book, first published in 1934 as *Television and Short-wave Handbook*, and progressively brought up to date in successive editions, now includes the latest information on modern systems of television, and also its many secondary applications such as noctovision, viso-telephony, and tele-projection in cinemas. The probable future trend of development in colour and stereoscopic television is also outlined. A comprehensive dictionary of television terms is included, together with the list of standard terms and control markings as agreed upon by the Television Committee of the Radio Manufacturers' Association.

**The Boy's Book of Engines, Motors and Turbines**, by Alfred Morgan. (London : The Stanmore Press, 25, Thurloe Street, S.W.7.) Price 10s. 6d. net.

Many books have been written with the object of instructing the juvenile mind on the elementary principles of engines and scientific apparatus, and nearly all of them have their merits, but this book deserves special praise, not only for the comprehensive nature of its contents, but also the lucid explanations and the 260 illustrations which it contains. It begins with a chapter on steam engines, followed by others on electric generators, turbines, hydro-electric plant, water wheels, oil power, internal combustion engines of all types, and electric motors. In the concluding chapters of the book, instructions are given on how to make demonstration models, illustrating the principles dealt with in the foregoing part, including a steam turbine, mill wheels and water turbines, electric motors, and a piston-valve steam engine. An attractive book for the coming generation of model engineers.

**British Time**, by Donald de Carle. (London : Crosby Lockwood & Son Ltd., 39, Thurloe Street, S.W.7.) Price 15s. net.

This book deals with horology from a somewhat unusual aspect; namely, the development of time-recording methods and systems, which have become a British national institution, in a manner which has so far no parallel in other countries. It gives a good deal of information on the history and development of all kinds of clocks, leading up to the modern observatory methods of time recording, the public clock, of which Big Ben is the finest example, electric master and secondary clocks, synchronised and synchronous types, time signals by wire and wireless, and the evolution of the speaking clock "Tim."

Great pains have been taken to ensure accuracy both in the historical and technical subject-matter of the book, and wherever possible, the most competent authorities in the particular fields of specialised design or development have been consulted, both before and after the compilation of the manuscript. As a result, the documentary authenticity of the information in the book should be beyond all question.

In an appendix to the book, a chronological table is given of the major inventions and items of interest in the development of horological science. This not only makes interesting reading, but should help to dispel that inferiority complex which is so prevalent in our country today, for it shows that most of the really important exponents of this science in the past were British, and even at the present day, Britain is still well to the fore both in the scientific and practical spheres of horology. The book is very well illustrated by line drawings in the text, and numerous full-page half-tone plates on art paper.

# The Dendy-Marshall Valve-Gear

## by K. N. Harris

THIS gear was designed, primarily for locomotive work, by the late Mr. Dendy-Marshall, around 1913. So far as my memory takes me, it has not been described in *THE MODEL ENGINEER*. It has certain attractive features for model work and is extremely adaptable, being equally well suited for two-cylinder inside or outside, four-cylinder with 180 deg. setting or three-cylinder (with three separate sets of gear for preference).

that the slide absorbs more power in friction than the link. It has, however, two quite important advantages: (a) it is quite rigid in a sideways direction and avoids any possibility of what the "Southern" (U.S.A.) people call "Side Slap." (b) It allows freedom in choosing the most suitable radius for the slide to ensure symmetrical motion. In the Southern gear this freedom is constrained by the length which swinging guide-link can be made, which is generally less than

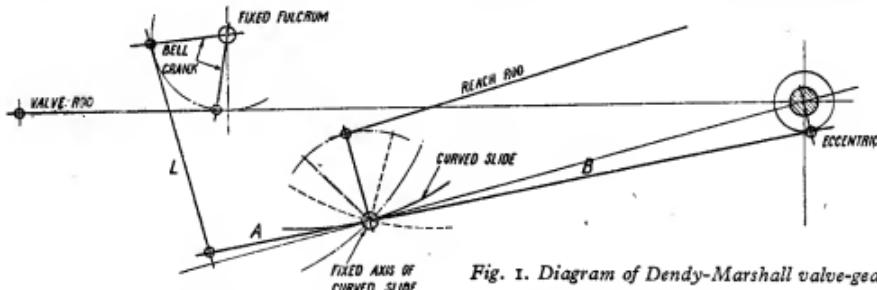


Fig. 1. Diagram of Dendy-Marshall valve-gear

It can be used with valves above, below or at the side of the cylinder and, of course, for either inside or outside admission. It is equally adaptable to engines driving on to the first or second axle. As those familiar with valve-gears will realise, this gear belongs to the Hackworth family, and requires only one eccentric.

It is identical in principle with the American "Strong" gear of 1888, better known in later years as the "Southern" gear; but it substitutes the swinging guide-link of the former by a curved slide, as used in the Joy gear. This has one slight disadvantage, which is probably of more academic than practical importance, namely,

will give the most desirable arc.

Mr. Dendy-Marshall gives a simple formula for ascertaining this radius which is :

$$\frac{A + B}{B} \times L \text{ where } A = \text{length of eccentric-rod beyond slide.}$$

B = length of eccentric-rod between centre of eccentric and slide pivot pin.

L = length of link connecting eccentric-rod and bell crank.  
(See Fig. 1.)

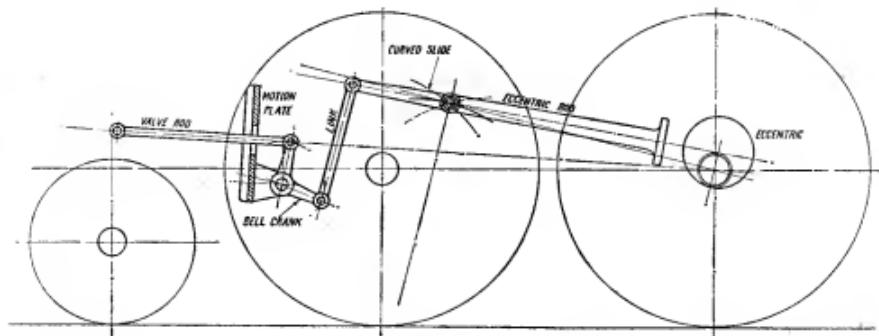


Fig. 2. Diagram of Dendy-Marshall valve-gear, as applied to "Atlantic" or 4-6-0 type loco.

There are a few general points about the setting out which may be useful :

- (1) With the crank on dead centre, the eccentric must be set at 90 deg., to the line passing through the crankshaft centre and the curved link pivot, whether in advance or behind the crank depending on whether the admission is inside or outside.
- (2) Taking the centre-line through crankshaft

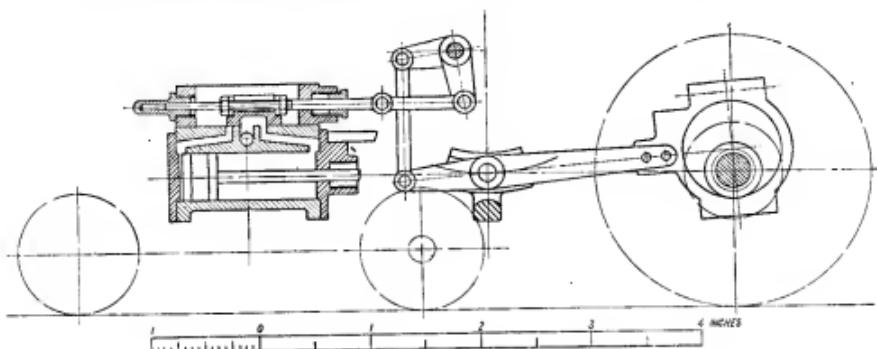


Fig. 3. The Dendy-Marshall valve-gear

and curved link pivot and then on one side or the other of the centre-line through the eccentric, at 90 deg., to this line, and the curved link pivot, the distance moved by the outer end of the eccentric-rod must equal lap plus lead (assuming normal practice with the two arms of the bell-crank of equal length).

- (3) The arm of the bell-crank connected to the valve-rod should be at 90 deg. to this rod with the valve in mid-position.
- (4) The connecting-link between eccentric-rod and bell-crank should be at 90 deg. to the centre-line of crankshaft and curved slide axis when eccentric is also at 90 deg. to this line. (This is not strictly true geometrically, but is correct for all practical purposes.)
- (5) The arm of the bell-crank to which the connecting-link is fastened should be at 90 deg. to the connecting-link when eccentric is in position mentioned in (4). (Again not geometrically absolute, but for practical purposes O.K.)
- (6) The concave side of the curved slide always lies on the same side as the bell-crank.

Fig. 2 shows Mr. Dendy-Marshall's own proposed arrangement for a gear to suit an "Atlantic" or 4-6-0 driving on to the second axle.

If more convenient for any reason, the slide may be placed below the centre-line of the valve-motion instead of above, as shown.

Fig. 3 shows the valve-gear as worked out for a modern 4-4-0 with outside cylinders, of 1½-in. gauge, 10 mm. to the foot scale.

The valves have 1-in. travel in full gear; steam ports  $\frac{1}{8}$  in.  $\times$   $\frac{5}{16}$  in.; exhaust ports,  $\frac{1}{4}$  in.  $\times$   $\frac{1}{16}$  in.; valve lap,  $\frac{1}{16}$  in.; exhaust cavity, line-and-line; lead, barely perceptible; cut-off 8 in. full gear, approximately 75 per cent.

As will be observed, the gear can be made very robust, and its adaptability to a wide variety of conditions is self-evident.

In common with Joy, Hackworth and Marshall gears, it is affected as to the accuracy of its steam distribution by the "up and down" motion of the driving axle and it is desirable that the axleboxes of this axle should be controlled by stiffish springs.

A brief study of the gear will indicate that the eccentric-rod acts as a lever of the first order and not in tension and compression alternately as with the normal gear of any of the link-motions, or Walschaerts type. For this reason, it should be made really stiff to resist any tendency to bend. The gear gives an excellent steam distribution when properly made.

For those interested in its mathematics and finer points of design, an article in *The Engineer* for June 20th, 1913, will be of the greatest value; there, the late Mr. Dendy-Marshall deals with it exhaustively.

## To Clean Paint Brushes

IMMEDIATELY after use, wash well in clean paraffin, in a suitable tin, *at once* emptying the paraffin into a second tin. The paint from the brush quickly settles, leaving the paraffin clear. Leave it in the second tin until again required, when it should be returned to the first tin, the brush washed as before and

the paraffin returned at once to the second tin.

Thus the first tin is always clean and the sludge collects in the second, which can be emptied as occasion requires.

Brushes remain soft.

The paraffin lasts for months and can be used several times a day.—R. A. VAN VESTRAUT.

# AN INDEX DIAL

by R. F. Slade

BEING the unfortunate owner of a lathe with a cross-slide feedscrew of 12 t.p.i., I was very interested in the article by "Duplex" in the issue of April 8th, 1948, concerning index collars, for this article happened to be published just as I wanted to make this addition to my lathe, which I had just acquired—interested, that is, until I came to the part where they state that those possessing such a feedscrew would do best to make and fit a new feedscrew and nut. This was a bit of a blow, as I hadn't the time for such an operation. I

wanted an index dial "on the quick," so I had to get down to the job myself.

As "Duplex" state in their article, with a feed-screw of 12 t.p.i., it is impossible to obtain divisions representing one-thou. of slide travel, but after a little thought, it was found that it was possible to obtain travel one-third of a thou. In other words, the index dial would have to be divided into 250 equal parts, this being apparent by the fact that one thread of a 12 t.p.i. feedscrew moves the slide 0.0833 in., and multiplying this by three gives 0.2499 in., which is near enough to 250.

## Working Overtime

This presented difficulties, for the change-wheels, it was found, could not be arranged to give the necessary indexing, and nothing was to hand that could be used as a dividing aid. I certainly did not fancy making up a plate, marking out, and drilling 250 holes, and then making up some means of locating, such as a plunger. I began to wonder if it would not be better to make a new feedscrew and nut after all! In the meantime the old noddy was working overtime. What now? There must be some way—and as usual, there was! I chanced to notice my straight knurling wheel lying on the shelf, and out came the scribbling-pad and pencil, for surely, with a little calculation here was the very thing. On checking up, it was found that this particular knurling wheel was 0.500 in. diameter, and had 56 teeth (though any wheel of accurate manufacture with a pitch of 0.020 in. to 0.040 in. could be used with the same calculation. It is advised to keep within these sizes, as a wheel of smaller pitch would make the divisions on the dial too small, and a larger pitch would

have exactly the opposite effect). Therefore, in my case, the diameter being 0.500 in. the circumference equalled 1.5708 in. and this divided by 56 (the number of teeth) gave me a pitch of 0.02805 in. Knowing I required 250 divisions on the index dial to give divisions of a third of a thou., I multiplied  $0.02805 \times 250$  (pitch by number of divisions) = 7.01250, which was the circumference of the index dial required. By dividing this sum by  $\pi$  gave me the diameter. Therefore, diameter,  $7.0125 - 3.1416$ , gave me 2.2321,

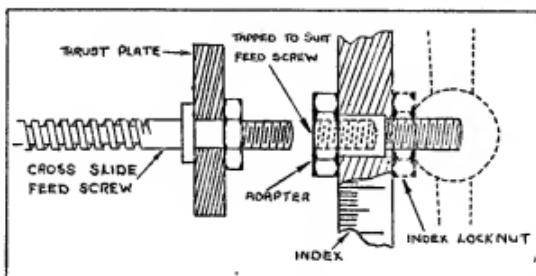
the diameter of index required.

This was duly made up out of dural mounted on a mandrel, and without removing from the mandrel, the knurling wheel was run up to the work until just touching, then, by turning the mandrel of the lathe by hand and very gently feeding in, perfect divisions were marked out, each representing a third of a thou., or at least, so I hoped.

## Graduating

Obviously, these would have to be marked off into thou.'s., 5 thou.'s. and 10 thou.'s. respectively. So, in the usual manner, with a tool ground to a V and mounted on its side at dead centre, the graduating was next proceeded with. Every third division was extended to  $\frac{1}{16}$  in. in length, this took care of the thou.'s. Every 5 thou. was extended  $\frac{1}{32}$  in. and every ten thou. to  $\frac{1}{16}$  in. This resulted in quite a professional appearance. Unfortunately, dividing the divisions up in this manner leaves one odd division, as the dividing works out at eight complete banks of ten thou.'s. (240 divisions), and three odd thou.'s., with one third of a thou. over. However, this is a small matter in view of the fact that I now have an index dial which is "spot on," for, on trying out the dial mounted up on the cross-slide feedscrew, it was found that no error was apparent.

The attachment for fixing the dial to the cross-slide feedscrew was a simple job, the drawings being self-explanatory. It is admitted that a better method of resetting the dial to "0" could be devised, as at the moment the index dial locknut has to be loosened to permit this. However, it is proposed to attend to this matter in the near future.



# A SIMPLE ELECTRIC PYROMETER

by A. R. Turpin

A PYROMETER is simply another name for a thermometer, but is usually associated with those instruments used for measuring the higher temperatures. Such an instrument is almost a necessity when undertaking operations as heat treatment, tempering, hardening, foundry work and the recording of cylinder-head temperatures etc.

There are a number of simple ways of measuring high temperatures open to the amateur. For instance, the writer, wishing to use some "Araldite,"—that plastic cement recently described in *THE MODEL ENGINEER*—wanted to be certain of the maximum temperatures reached by the oven, and for this purpose a piece of bright steel was placed beside the object being cemented and the maximum temperature clearly indicated by the colour of the steel strip. A list of these colours is given in Table I.

Degrees Centigrade	Tempering Colour
220	Very pale yellow
230	Pale straw
240	Straw
250	Deep yellow
260	Brown
270	Brown purple
280	Purple
290	Blue
300	Blue black

TABLE I

For higher temperatures, the luminous colour range can be used, and these have the advantage over the tempering colour by being reversible, and by that it is meant that if the temperature is lowered the tempering colour will not change, but those of the luminous colour range will. These are shown in Table II.

Degrees Centigrade	Luminous Colour
400	Red heat visible in the dark
470	" " " in dim light
520	" " " in daylight
580	" " " in sunlight
700	Dark red
800	Dull cherry red
900	Cherry red
1000	Bright cherry red
1100	Orange red
1200	Orange yellow
1300	Yellow white
1400	White heat
1500	Brilliant white
1600	Dazzling bluish white

TABLE II

These colours, however, are very approximate when judged by the unaided eye, and considerable experience is required to get within 100 deg. of accuracy.

A second, more accurate method of obtaining a measure of the higher temperatures but which is again irreversible—is the use of Seger cones. These cones are made of refractory materials of different melting points and are marketed in steps of 20 deg. C., the lowest being 600 deg. C. and the highest 2,000 deg. C. They measure about  $2\frac{1}{2}$  in. high and  $\frac{1}{2}$  in. at the base, and are numbered as follows: No. 022 = 600 C., No. 021 = 600 C., and so on to No. 01 and then Nos. 1, 2, 3, etc. up to No. 42, which represents a melting point of 2,000 deg. C.

Fig. 1 shows these cones and the shape they would approximately assume if subjected to a heat of 1,100 deg. C., which temperature is indicated by No. 1 cone. These cones are usually stood on a piece of firebrick and placed in the oven or furnace clear of the direct flame. Three cones are used, the centre one being that of the temperature desired.

A further method suggested by Breamley is to melt together a mixture of salts of different melting points, and having ground the mixture to paste with, say, petroleum jelly, smear some on a piece of the metal after it has been brought to almost red heat. On reheating, the white mark left by the salts will disappear just before the correct temperature is reached. A list of these mixtures is given in Table III.

Parts of salts by weight		Melts deg. C.		
Pot. Carbonate	50	Pot. Chloride	50	580
Sod. Chloride	30	"	"	625
"	42	"	"	655
Pot. Sulphate	20	Sod. Sulphate	80	825
"	50	"	50	825

TABLE III

By far the most convenient method of measuring high temperatures is by means of a thermoelectric pyrometer, the principle of which is as follows:—

If two lengths of wire of two dissimilar metals are formed into a loop by twisting their ends together, as in A, Fig. 2 and, say, the left-hand end is heated, an electromotive force is set up at the junction causing a current to flow round the loop. If we now break the loop at the cold junction and insert a micro-ammeter, the current flowing will be indicated by the meter; and, as the current will be approximately proportional to the temperature of the hot end, or rather the difference between the hot and cold junction, we can use the reading of the meter as an indication of the temperature of the hot end of the loop. Different pairs of metals will produce

different E.M.F.'s and to give the reader some idea of the E.M.F. produced in millivolts, the following are those given by three different combinations with the hot ends heated to 500 deg. C., and the cold ends to 0 deg. C. Copper-Constantan 27 M/V, Chrom-Alumel 20.6 M/V, Iron-Constantan 28 M/V, Iron/Eureka 27 M/V.

It will be seen from the foregoing that if we wish to construct such a pyrometer, we must first decide the maximum temperature that we

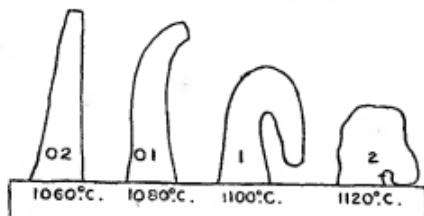


Fig. 1. Seger cones, showing different stages of collapse. No. 1 indicates correct heat

wish to measure, and then choose a pair of metals for the junction which will give us the greatest E.M.F. and yet stand up to the greatest heat to be measured. We must then obtain a meter of such a resistance and sensitivity that the highest temperature will give us almost a full scale reading. If some sort of real accuracy is desired, then there are a number of further points that must be taken into consideration. First, as the resistance of metals varies with temperature, the resistance of the meter should be high compared to that of the couple; secondly, as we are measuring the difference between the temperatures of the hot and cold ends, some means of ascertaining the temperature of the latter must be arranged; thirdly, means of calibrating the instrument must be found if no standard instrument is available for this purpose.

The writer required a pyrometer for the measurement of the temperatures of molten non-ferrous metals, and decided that this could most easily be achieved by making the couple about 18 in. long, connecting the cold end direct to the meter and simply dipping the hot end directly into the molten metal. As the time of immersion would only be a matter of seconds, it was decided that the room temperature could be taken as the cold end temperature, and a couple consisting of iron/Eureka wire of 18 s.w.g. would not only give a high E.M.F. but would be able to stand up to the temperatures required.

The couple was first connected to a meter of 100 ohms internal resistance and a full scale reading of one milliamp., but on dipping the hot end into molten bronze, the needle only moved over about one tenth of the scale. Next, a thermo-ammeter reading 0.6 amps. was brought into service.

The movement was removed from its case and the connections to its original couple contained inside, unsoldered. The iron/Eureka wires were connected temporarily in their place and once

again the hot end was dipped in the molten metal. This time the result was quite different, the needle flying across the dial and up against the stop. Substitution of nickel-chrome wire for Eureka reduced the sensitivity so that the needle stopped at the 5 amp. mark on the dial, which suggested that this mock-up would just about fill the bill; so, to confirm the point, a short length of bare 14 s.w.g. copper wire was wound closely round the twisted hot end of the wires and a small blowlamp flame gently played on it. The needle slowly moved across the dial until the copper commenced to melt, when it remained stationary until the copper had completely melted, after which it moved on again.

At the point the needle of the meter remained stationary, indicating clearly the melting temperature of copper, 1,083 deg. C., and just within the scale of the meter. It was, therefore, decided to make a permanent job of the mock-up.

A rather better method of bringing down the sensitivity of the meter would be to use the more sensitive "Eureka" couple again, and increase the resistance of the meter by winding a small coil of manganin wire, connecting this in series with the moving coil of the instrument. Manganin wire has a low temperature coefficient of resistance, and the increased resistance of the meter will reduce the effect of the temperature coefficient of the couple.

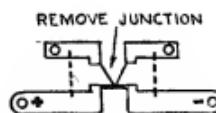
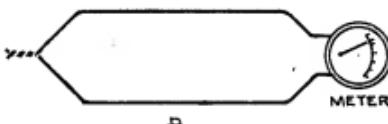
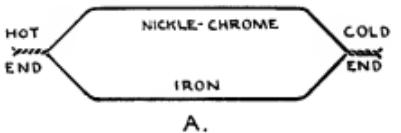


Fig. 2

The final arrangement for a practical instrument is shown in Fig. 3. The meter, as previously mentioned, was originally a 0.6 amp. thermo-couple instrument with a 2-in. dial. These instruments are quite plentiful at the moment in "surplus" stores, and can be purchased for a few shillings. The movement is removed from its case, the two screws holding the dial are taken out and the latter removed. The fine wires forming the couple can now be seen as shown in Fig. 2c. These are removed with snips and the tags joined with a length of copper wire as shown dotted in Fig. 2c.

The dial is painted out and redrawn with equal divisions 0-10, subdividing as small as practicable, or this may be left till later and actual degrees of temperature marked in, but this may not prove too satisfactory, as the instrument will have to be recalibrated from time to time. This is easily done with a dial marked 0-10, because a reference graph may be used and any corrections made to this. The dial and movement are then replaced

accomplish this, the end of the wire forming the couple may be bent at right-angles. Each type of wire has a certain polarity and should be connected to the appropriate terminal, this to be found by trial. For higher temperatures than 1,100 deg. C., couples consisting of precious metals must be used such as Platinum/Platinum

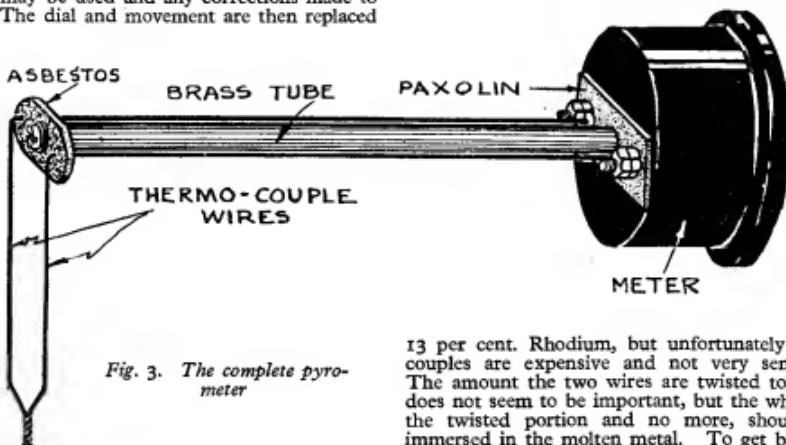


Fig. 3. The complete pyrometer

in the case, including the manganin resistance coil, if one is used.

A piece of brass or steel tubing of any gauge is cut about  $\frac{1}{8}$  in. diameter and the ends are plugged, drilled and tapped 2 B.A.

A piece of insulating material  $\frac{1}{8}$  in. thick, 1 in.  $\times$  2 in. is cut, and here paxoline will do. The distance apart of the terminals on the meter is measured and two holes drilled in the paxoline this distance apart so that it may be placed over these terminals. Before doing this a 2-B.A. clearance hole is drilled between them, and by means of a cheese-headed screw, the length of tube is fixed to the paxoline, which in turn is fixed to the meter by means of the terminal posts.

Fixed to the other end of the tube by another 2-B.A. screw is a small piece of asbestos board, mica or porcelain, in which are drilled two  $\frac{1}{8}$ -in. holes. Two 18 in. lengths of the wires to form the couple to the terminals of the meter are connected and threaded through the holes in the piece of asbestos; the ends are twisted tightly together for half an inch and painted over with a 50/50 mixture of fireclay and sodium silicate (water-glass) and the pyrometer is ready for calibrating.

A suitable size of wire to use for the couple is 20 s.w.g.; a difference of a gauge or two either way does not matter.

Only the twisted end should be placed in the molten metal, otherwise the metal will act as a short and an error will result in the reading. After considerable use, the hot end will erode to some extent, but all that need be done then is to cut the twisted end off and retwist. The pyrometer should be held in such a way that the cold end is kept the coolest part; and in order to

13 per cent. Rhodium, but unfortunately these couples are expensive and not very sensitive. The amount the two wires are twisted together does not seem to be important, but the whole of the twisted portion and no more, should be immersed in the molten metal. To get back to the calibration of the instrument, molten metals are used for this purpose and, of course, must be pure. Quite a small crucible, or the screw cap of a  $\frac{1}{2}$ -in. gas pipe will do, but it should be first given a coat of clay and sodium silicate. The metal is melted and the end of the couple inserted. When removed from the heat the needle will slowly fall back. When it reaches the freezing point the needle will halt for a while and continue to fall. The point of the halt is the point wanted. If the process is reversed the needle will rise; it will again halt at the melting point and this should coincide with the previous point. Suggested metals are as follows: Tin, 271 deg. C., Lead, 327 deg. C., Aluminium, 658 deg. C., Silver, 960 deg. C., Copper, 1,083 deg. C. If silver is too expensive, sodium carbonate can be used 849 deg. C. A graph is then plotted from these readings and intermediate temperatures arrived at from this. On my own meter which has a scale divided into 100, lead comes at 5, aluminium at 45, silver 81 and copper 98.

A pyrometer of this type if carefully made, used, and calibrated, should give an accuracy of between 1 and 2 per cent.

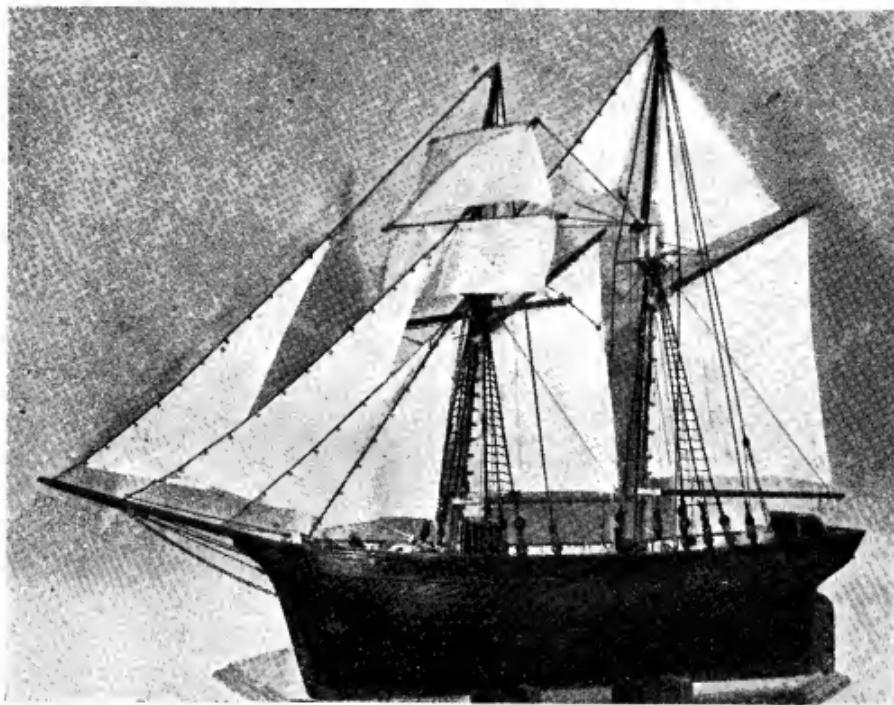
For taking cylinder-head temperatures, the couple can be hard-soldered to a copper washer which can replace the plug washer. In order to obviate the chance of a short against the cylinder-head, the couple wires should be enclosed with porcelain beads.

If it is desired to fix the pyrometer permanently in place in a furnace or oven, the couple should be protected. First, each wire is threaded through porcelain or lava tubes, or coated with fireclay; then the ends are twisted and enclosed again in a sealed tube of porcelain which can be cemented into the firebrick of the furnace, the end, of course, protruding into the furnace proper.

## A ROMFORD EXHIBITION

THE second post-war exhibition of the Romford Model Engineering Club was opened by Lord Braintree, at the Lamourne Hall, Romford under the Chairmanship of Mr. A. C. Rhodes. His Lordship stated that when getting old, the great effort was to keep young,

been entered after the catalogue had gone to press, and in fact the members in charge of some of the stands were at times hard put to it to keep pace with the new arrivals. The woodworking exhibits in the miscellaneous and machine tools section were greatly admired, whilst on the



*A model two-masted schooner by Alf Whitten, exhibited at Romford*

and he thought that model engineering was a great means to that end. He was of the opinion that model engineering, when followed by parents, enabled them to think in the same terms as their sons and daughters. A. R. Dunbar, M.B.E., vice-president of the Club, proposed a hearty vote of thanks to Lord Braintree for opening the exhibition. A wire recording of the ceremony was made by Stan Carr on his home-made apparatus.

In the entrance hall a fine display of photographs arranged by Mr. C. C. Millar, whetted the appetite for the great variety of exhibits within the main hall. The club members had set out to improve upon the last year's show and succeeded in introducing a surprising amount of new material. More than two hundred models were exhibited, a great many of them having

stationary engines stand. Mr. S. W. Simpson's fine collection of models made a welcome reappearance, Mr. Buckle's splendid 1½-in. scale steam traction engine, and Mr. Dupen's contractor's locomotive were among the models operating on compressed air, and, as a result, it now seems highly probable that a fleet of traction engines will emerge from amongst the club's members. In the marine section the exhibits ranged from Mr. Cadman's "full-rigged ship in a test tube," to Mr. Beeson's well-known 10-rater yacht, with Mr. Cramp's fine model of the "Victory" forming a centre-piece.

As might be expected at this club, which was the first in this country to build a continuous 2½ in. gauge track, there was a super-abundance of locomotives, both completed and in every stage of construction, and a section of the new

all-steel multi-gauge passenger-carrying track was in operation throughout the exhibition. Eric Clarke's Mountain-type locomotive and his huge free-lance Pacific type locomotive did most of the passenger hauling, whilst Eddie Bailey's "Music" was in steam at both the opening and the closing of the show.

At frequent intervals, talkie films of model engineering interest were shown, the fine stage at the end of the hall having been converted into a cinema, the dressing rooms at either side forming a ready-made booking hall, and providing ingress and egress for the audience.

The Romford Club was pleased to welcome the

Essex Power-model Aircraft and Racing Car Club, and also the Ilford and West Essex Model Railway Club, with their exhibits, the working miniature trains being an unfailing attraction.

Some two thousand visitors patronised the show during the fourteen and a half hours which it was open to the public. Only those good folk who have attempted to stage an exhibition of such magnitude can visualise the enormous amount of work involved, and recognition is due to the exhibition committee Messrs. Chilver, Carr, and Blyce (and particularly to the last named who in addition to his administrative duties also became general carpenter).

## PRACTICAL LETTERS

### Superfine Feed Attachment

DEAR SIR.—In reply to Mr. Watson's letter in THE MODEL ENGINEER of November 25th, 1948, I would say that *Machinery's* formula is a rationalisation of the theoretically correct one, viz. ratio =  $\frac{\pi \times \text{t.p.i. of leadscrew}}{\text{d.p.}}$ . The

approximation lies in the use of  $\frac{22}{7}$  as an equivalent for  $\pi$ , of which the correct value is 3.14159213 ... and the error is 1 in 2,483.

The figures given in *Machinery's* table will give perfectly satisfactory results for most purposes, but if special accuracy is desired (e.g., to couple the hob and blank drives in gear hobbing) I should recommend 3-pair trains developed from the following fractions :

t.p.i. d.p.	4	6	8	10
14	$\frac{3R}{5}$	$\frac{9R}{10}$	$\frac{6R}{5}$	$\frac{3R}{2}$
16	$\frac{21R}{40}$	$\frac{63R}{80}$	$\frac{21R}{20}$	$\frac{21R}{16}$
18	$\frac{7R}{15}$	$\frac{7R}{10}$	$\frac{14R}{15}$	$\frac{7R}{6}$
20	$\frac{21R}{50}$	$\frac{63R}{100}$	$\frac{21R}{25}$	$\frac{21R}{20}$

Where  $R = \frac{11 \times 17}{5^2} = \frac{187}{25}$

The odd sizes will, of course, have to be made specially. When I made my fine-feed worm drive I used the following train :  $\frac{34}{25}, \frac{42}{40}, \frac{44}{50}$  of which I had to make 34, 42 and 44 specially (my lead-screw has 8 t.p.i. and the required d.p. was 20).

Yours faithfully,  
ALFRED H. JANES.

### Fowler Steam Ploughing Engines

DEAR SIR.—Mr. West's photograph on page 622 (December 9th issue) is an opposite-hand view of the type depicted on page 184 (August

19th) and thus dates from 1864-70. The letter by Mr. Rothwell (pp. 517-8, November 11th), gives some details of these engines. Unfortunately, those in the photograph have lost their characteristic dome which should conceal the safety-valves, the steering has been altered from that described by Mr. Rothwell, and I think longer smokeboxes have been fitted, as originally these engines had a projecting fore-carriage mounting.

Yours faithfully,  
R. C. STEBBING.

### Ploughing Engines

DEAR SIR.—Your photograph of two ploughing engines calls up a memory. Forty years ago when I was an Oxford undergraduate, I saw two exactly similar engines at work in a field in Cowley, on the east side of the old Cowley golf-links, on land now occupied by another links. I noticed that they were single-cylinder jobs, and heavily labelled "Oxford Steam Ploughing Company." I believe this company still existed before the war, and may still do so. They might know the makers. I remember admiring the skill of the ploughman controlling the plough unit—with its upright steering wheel—in staying aboard the lugger at all, as it rocked its way over the heavy uneven loam like a small boat in a seaway.

Yours faithfully,  
THOS. NELSON.

### Electric Bed-warmers

DEAR SIR.—This being the season for electric bed-warmers, I started to make one on the lines laid down by H.C.W. in the January 29th, 1948 issue. Half a linen sheet came in handy for the case and was soon stitched up, but when it came to winding 40-gauge wire on to fine string! well—one was apt to get discouraged to say the least of it, either one or the other kept breaking. Then I had my brainwave. The heater cord as used in small a.c./d.c. radio sets was the answer.

Seven yards of .3 amp. resistance line cord is just about right, threaded "V"-wise in the case. It is foolproof, safe and strong, cheap to buy and run, and heats the bed to a comfortable heat in 30 to 40 minutes, neither will it overheat. I had to use the 3-core variety which means I just ignored one rubber-covered wire. The other

one is bared for 1 in. and after removing the same amount of asbestos string from the resistance wire, is carefully wrapped round the latter and well taped up. The other end of the resistance wire is bared as before and whipped with fine copper wire to give a firm base for the set-screw of the connector. The other end of the rubber-covered wire goes to the other set-screw. I used an ordinary 5-amp. two-pin connector with the exposed pins to the heater. A switch at the bed head completes the job.

Hoping this will interest those whose wives suffer from cold feet.

Yours faithfully,  
Sleaford. F. NELMES.

#### The Wheels of "Puffing Billy"

DEAR SIR.—The articles by Edward Adams are always interesting, and the illustration of a model of *Puffing Billy* is very striking, when compared with a model of an American tender on the same scale.

But the maker of this model shows the wheels which are fitted to the early locomotive as it now exists, and as it appears in photographs taken at any time during the past sixty years or so, and I believe that the wheels which William Hedley used were probably very different.

The wheels at present fitted are the type with bent spokes and cast bosses which were in general use for very many years; but were they used in Hedley's time? I incline to the opinion that the original wheels must have been cast-iron spoked or disc wheels, of course of the same, or nearly the same, size, but very different in appearance, and one may suppose, without separate tyres. Therefore, when grooved and worn after many years of use, they could be thrown away, with no necessity to duplicate the original pattern, because they had no crankpins fixed in them, and thus the new wheels were of the plain wagon type.

In order, therefore, to establish what was the original condition of this locomotive, what possibility exists that the original form of these wheels might be discovered, and the correct replicas made of them?

In a book entitled "Railway Carriages and Wagons" by Sidney Stone, published about 1910, by *The Railway Engineer*, will be found, on pages 90-96, a very interesting account of the manufacture of wagon wheels, and anyone reading this will doubt at once whether the processes described would have been used in William Hedley's time.

Yours faithfully,  
London, N.W.7. H. H. NICHOLLS.

## CLUB ANNOUNCEMENTS

### The Sheffield and District Society of Model and Experimental Engineers

News of the above society has been conspicuous by its absence for some considerable time, but the activities of the society have, however, been very much alive, and recent events of interest included a visit to B.T.H. Works at Chesterfield, and one to the new strip mill and furnace shop of Messrs. Steel Peach & Tozer Ltd., of Sheffield. The highlight of the latter visit was the tapping of a 90-ton capacity Siemens furnace, a sight which has to be seen to be appreciated.

At the annual general meeting a new Public Relations Officer was appointed to take the place of Mr. Hughes, who has succeeded Mr. Kerry as vice-chairman.

On February 3rd a talk on "Jigs and Fixtures" will be given by A. Throp.

In addition to the existing activities of the society, a model railway club is in the process of being formed, to be run as a branch of the parent society. This is still in its embryo stage, so if any reader is interested will be pleased to get in touch with either of the undermentioned.

Hon. Secretary: A. MILNES, 20, Castlewood Road, Fulwood, Sheffield, 10. Tel.: 31142. Public Relations Officer: E. D. D. ADAMS, 8, Westwick Crescent, Greenhill, Sheffield, 8.

### The Society of Model and Experimental Engineers

On the retirement of Mr. E. L. Ashton as hon. secretary of the above society, the duties have now been taken over by Mr. Alex B. Storrar, 67, Station Road, West Wickham, Kent, to whom all future correspondence should be addressed.

### The Model Power Boat Association

The annual general meeting of the M.P.B.A. will be held on Saturday, January 29th, 1949, at the hall of the Central Club, 127, Clerkenwell Road, London, E.C.1 (next to Holborn Hall), commencing at 2.30 p.m. All affiliated members of clubs forming the M.P.B.A. are entitled to attend this meeting and are strongly urged to do so, as matters of vital interest to model power boat enthusiasts will be discussed and voted on.

Provincial clubs who may be unable to send any representatives are invited to contact the hon. secretary over any matters they wish to raise, including any regatta dates for the 1949 season.

Hon. Secretary: J. H. BENSON, 70, Broadfield Road, Cattford, S.E.6. Hither Green 1486.

### Leicester Society of Model Engineers

The next meeting of this society will be held on Tuesday, January 18th, at 7, Wellington Street, at 7 p.m.

Our annual Rummage Sale will take place at this meeting and members are asked to bring along those unwanted bits and pieces and tools, and convert them into cash.

The following meeting to be held on Tuesday, February 15th, will be devoted to ship models and their power plants.

We extend to all out model engineering friends cordial seasonal greetings and good luck in 1949.

Hon. Secretary: E. A. FRANK DALLASTON, 67, Skipworth Street, Highfields, Leicester.

### Sutton-in-Ashfield S.M.E.E.

On behalf of the members of the above society, I the hon. secretary would like to thank Mr. C. Moore and his colleague for the very efficient way in which our recent visit to the Myford Engineering Works was arranged and conducted, when the whole process of manufacture of the range of Myford lathes and accessories was fully explained. The visit was thoroughly enjoyed by all members participating.

Further visits are to be arranged shortly to other places of interest.

Hon. Secretary: J. CORBETT, Stanton Hill, Nr. Mansfield.

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Readers desiring to see the Editor personally can only do so by making an appointment in advance.

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